

Anatomy Hand-out

THORAX



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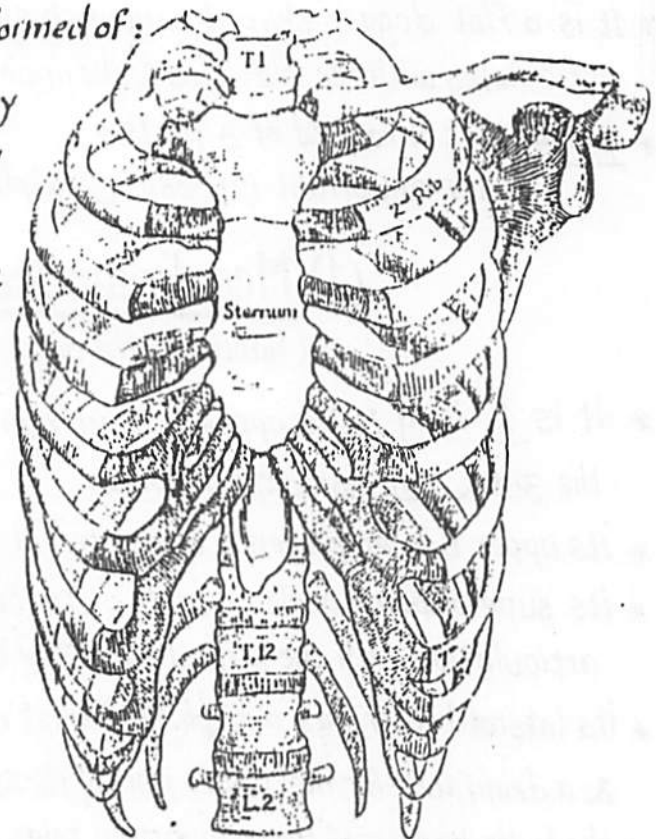
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The Thoracic cage

1

(A) Structure : the thoracic cage is formed of:

- (1) the vertebral column :----- posteriorly
- (2) the sternum :----- anteriorly
- (3) 12 pairs of ribs & their costal cartilages:----- on either side



(B) Functions :

(1) Supportive & protective function:

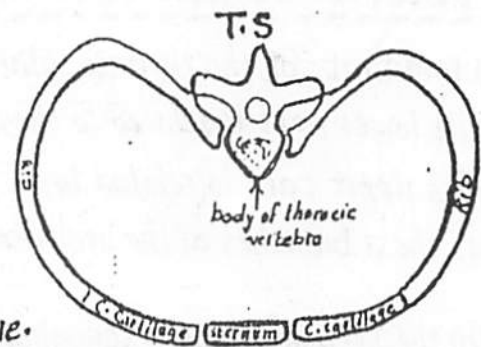
- (a) it supports & protects the thoracic viscera.
- (b) its lower part protects the upper abdominal viscera.

(2) Respiratory function:

the increase in the capacity of the thoracic cage (due to elevation of ribs & forward movement of the sternum) leads to decrease of the intra thoracic pressure & sucking of air into the lungs in inspiration.

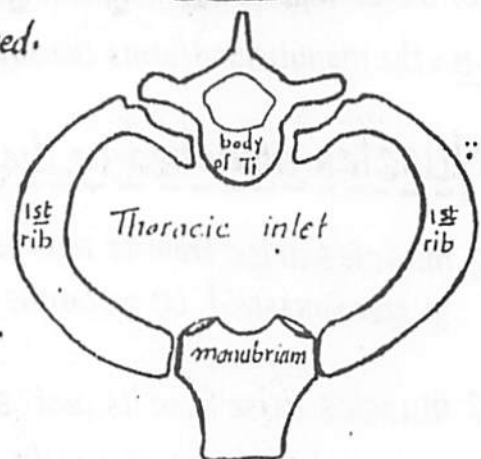
(C) Shape of the thoracic cage :

- * it is conical in shape, being narrow above & wide below.
- * its antero-posterior diameter is much diminished due to the forward projection of the bodies of the vertebrae.
- * In transverse section, the thoracic cage is kidney-shaped.



(D) The thoracic inlet (superior aperture) :

- * it is the upper opening of the thoracic cage at its junction with the root of the neck.
- * Boundaries & structures passing through : see page 19.



(E) The thoracic outlet (inferior aperture) :

- * it is the lower opening of the thoracic cage at its junction with the abdomen.
- * Boundaries & structures passing through it : see page 20.

Bones of the thoracic cage 2

1- the Sternum

* It is a flat dagger-shaped bone which supports & articulates with the clavicles & the upper 7 pairs of ribs.

* parts : it is formed of 3 parts :

(1) manubrium (2) body (3) xiphoid process.

(1) Manubrium Sterni

(handle of the dagger)

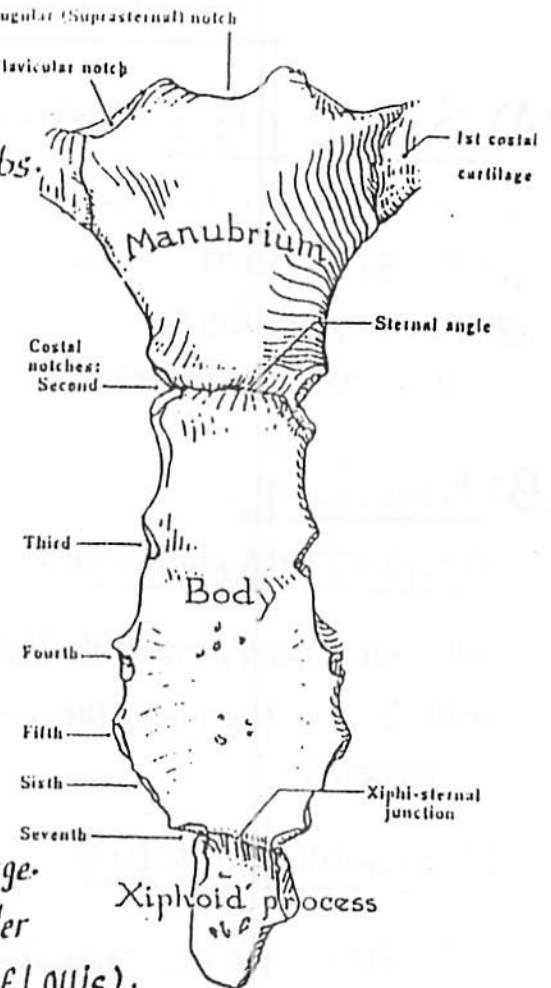
* it is 2" long & lies opposite 2 vertebrae :
the 3rd & 4th thoracic vertebrae.

* its upper border presents suprasternal (jugular) notch.

* its supero-lateral angle presents a clavicular notch for articulation with the sternal end of the clavicle.

* its lateral border has a notch for the 1st costal cartilage & a demifacet for the upper part of the 2nd costal cartilage.

* the lower border of the manubrium joins the upper border of the body of the sternum at the sternal angle (angle of Louis).



* Posterior relations of the manubrium:

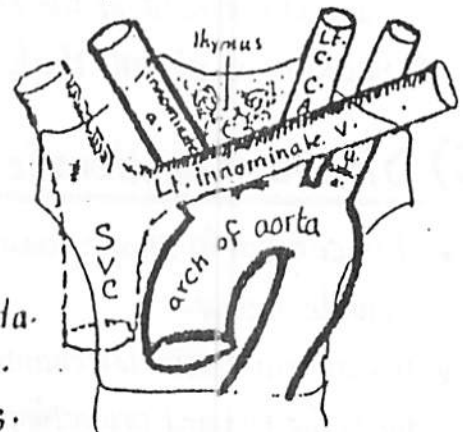
(1) remnant of the thymus gland.

(2) its lower part is related to the arch of aorta.

(3) its upper part is related to :

(a) the 3 branches of the arch of aorta — innominate a.
Lt. common carotid a.
Lt. subclavian a.

(b) the Lt. innominate v. (crossing in front of these 3 arteries).

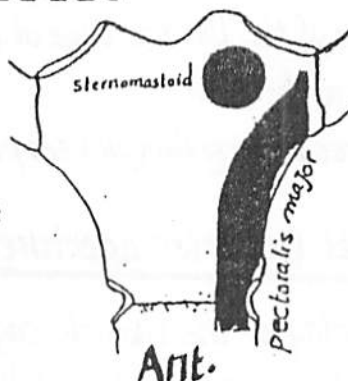


N.B : the manubrium forms the ant. boundary of the superior mediastinum

* Muscles attached to the manubrium:

- 2 muscles arise from its ant. surface:
(1) sternomastoid (2) pectoralis major.

- 2 muscles arise from its post. surface:
(1) sternohyoid (2) sternothyroid.



3

-
- Figure 3 shows anatomical drawings of the anterior portion of the thorax of a larva. The figure includes a frontal view of the thorax on the left and a side view of the thorax on the right. The frontal view shows the manubrium, sternal angle, body, xiphoid process, and xiphisternal joint. The side view shows the costal margin, third, fourth, fifth, sixth, and seventh ribs. A vertical scale bar is present between the two views.

ISLAND VIEW

-
- A diagram of the thoracic cavity. The lungs are shown on either side of the heart. The right lung is labeled 'Rt. lung & pleura' and the left lung is labeled 'Lt. Lung & pleura'. The heart is at the bottom, labeled 'Pericardium & heart'. Dashed lines indicate the boundaries of the lungs and pleura.

pericardium & heart

-
- The image contains two hand-drawn diagrams of the human torso, focusing on the chest and abdominal regions. The left diagram shows the anterior (front) view, with labels for the 'Ant. surface of sternum' and the 'pectoralis major' muscle. The right diagram shows the posterior (back) view, with labels for the 'post. surface' and the 'sternocapitalis' muscle. Both diagrams include a central vertical line representing the midline and a shaded area representing the internal organs.

The diagrams illustrate the anatomical locations of the rectus abdominis and diaphragm muscles. The left diagram shows the rectus abdominis muscle, and the right diagram shows the diaphragm muscle.

- * **CLINICALLY IMPORTANT POINTS RELATED TO STERNUM** : see page 97.

Thoracic vertebrae

4

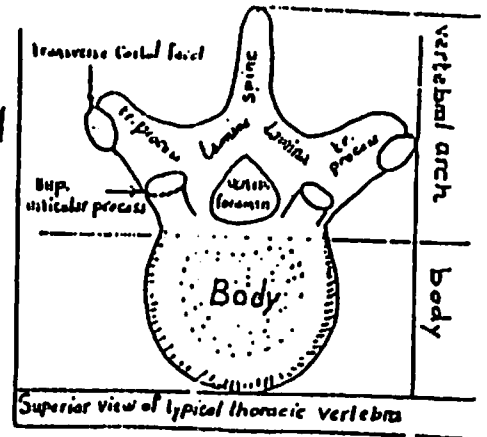
* They are 12 "rib bearing vertebrae".

* Structure:

- each vertebra is formed of 2 main parts

1- Vertebral body:

- it is the ventral strong part of the vertebra.
- it transmits the body weight downwards.

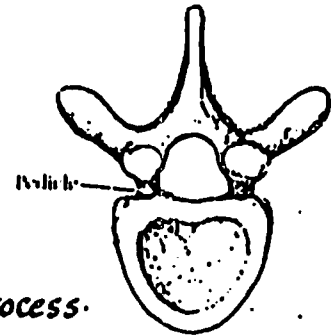


2- Vertebral arch:

- it is the dorsal part which surrounds the spinal cord.
- it is formed of the following parts:

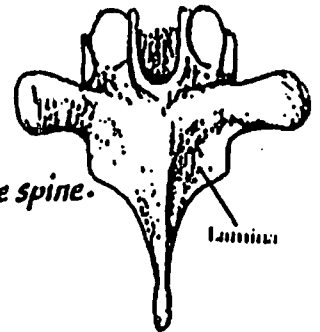
(a) Pedicle:

- it is the part extending from the body to the transverse process.
- the intervertebral foramina (which give exit to the spinal nerves) lie between successive pedicles.



(b) Lamina:

- it is the flat part of bone extending from the transverse process to the spine.
- the successive laminae are connected by ligamenta flava.



(c) Transverse process:

it is the laterally projecting process at the junction between the pedicle & the lamina:

(d) Spinous process (spine):

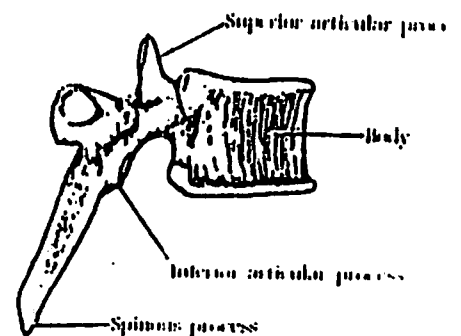
it projects backwards from the vertebral arch.

(e) 2 Superior articular processes:

Carry 2 articular facets for articulation with the inferior articular processes of the vertebra above.

(f) 2 Inferior articular processes:

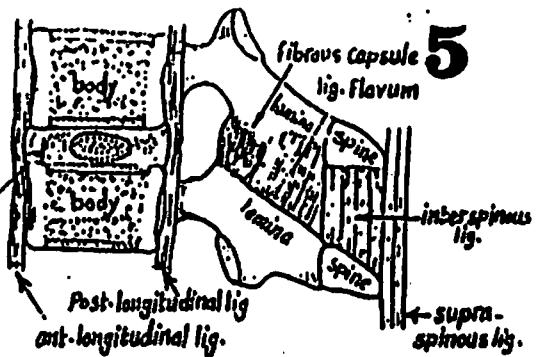
Carry 2 articular facets for articulation with the sup. articular processes of the vertebra below.



(3) Vertebral foramen:

- lies between the vertebral body & the vertebral arch.
- the successive vertebral foramina form the vertebral canal which lodges the spinal cord.

How Vertebrae are connected together?



- (1) Vertebral bodies : are connected together by:
 - (a) the intervertebral discs (2ry Cartilagenous joints).
 - (b) the ant-longitudinal lig. : connecting the ant-surfaces of the vertebral bodies.
 - (c) the post-longitudinal lig. : connecting the post-surfaces of the vertebral bodies.
- (2) Laminae : are connected together by ligamenta Flava (contain yellow elastic fibres).
- (3) transverse processes : are connected by intertransverse ligaments.
- (4) the Spines : are connected by:
 - (a) interspinous ligaments : connecting the adjoining spines
 - (b) supraspinous ligament : Connecting the tips of spines (from C7 to sacrum).
- (5) Articular processes of adjoining vertebrae are connected by the fibrous capsules of the intervertebral joints.

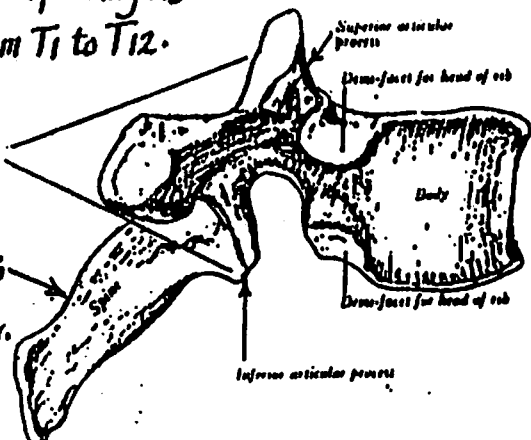
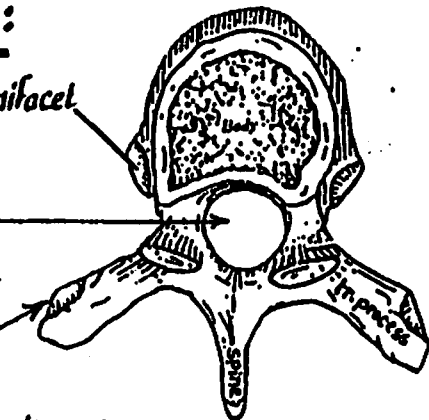
Classification of thoracic Vertebrae

(A) typical vertebrae
(from 2 - 8)

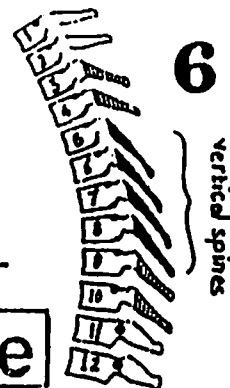
(B) non-typical vertebrae
(1st, 9th, 10th, 11th & 12th)

(A) Characters of the typical thoracic vertebrae:

- (1) The body : is heart-shaped & has sup. & inferior demifacet for articulation with heads of ribs.
- (2) The vertebral foramen is narrow & circular
- (3) The transverse process : is directed posterolaterally and has an articular facet near its tip anteriorly for articulation with the tubercle of the numerically corresponding rib.
N.B: the tr. processes become progressively shorter from T1 to T12.
- (4) The sup. & inf. articular processes are nearly vertical
- (5) The spinous process is long & directed downwards & backwards with varying degrees of obliquity.



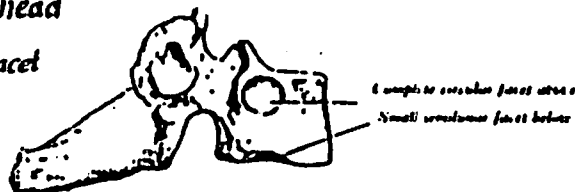
N.B : the spines of the middle 4 thoracic vertebrae (T5,6,7 & 8) are long & vertical but those above & below are progressively more horizontal.



Non-typical thoracic Vertebrae

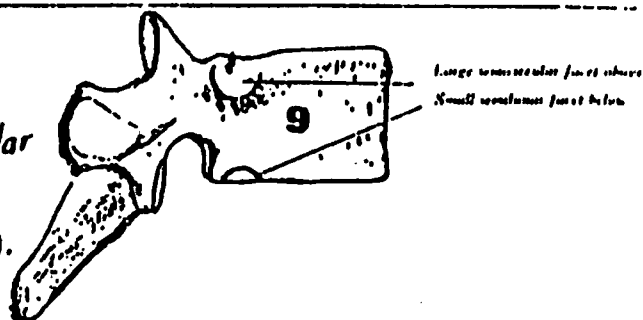
(1) The first (T₁) :

- the body is small in size and kidney-shaped.
- It has one superior complete facet (for the head of the 1st rib) and small inferior semilunar facet (for part of the head of the 2nd rib).
- the vertebral foramen is triangular.
- the spine is long & nearly horizontal.
- the transverse process has a costal facet.



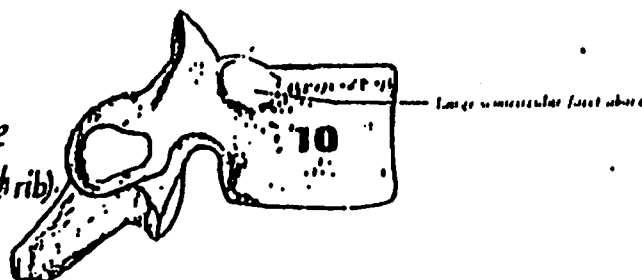
(2) The ninth (T₉) :

- the body is large, has large sup. semicircular facet (for the head of the 9th rib) & a small inf. semilunar facet (for part of head of 10th rib).
- the transverse process has a costal facet.



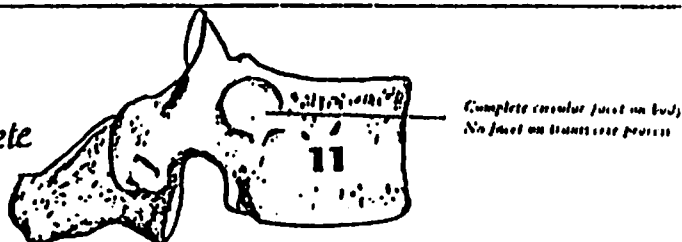
(3) The tenth (T₁₀) :

- the body is large & has only one large sup. semicircular facet (for the head of 10th rib).
- the transverse process has a small costal facet.



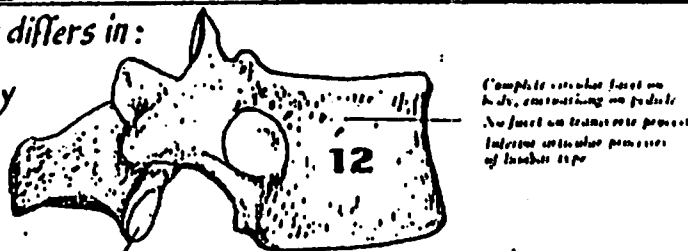
(4) The eleventh (T₁₁) :

- the body is large & has only one complete circular facet above (for head of 11th rib).
- the transverse process is small & has NO costal facet.



(5) The twelfth (T₁₂) : like T11 but differs in :

- the complete circular facet on the body encroaches on the middle of the pedicle.
- the inf. articular facet is directed laterally instead of forwards.



* For detailed anatomy of the vertebral column see page 93.

Ribs (costae).

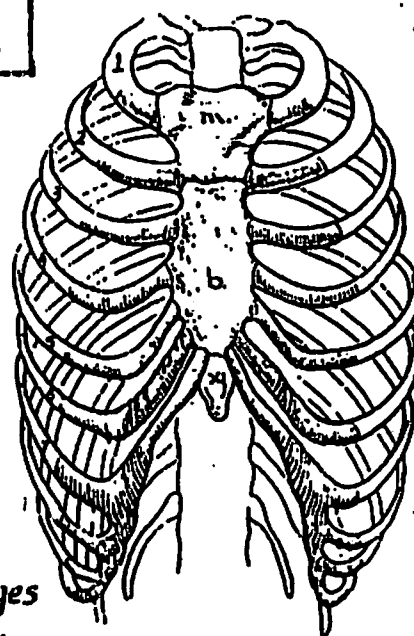
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There are 12 pairs of ribs, all of them articulate posteriorly with the bodies of the thoracic vertebrae.

Classification of the ribs

I- Classification according to their relation to sternum:

- (1) True ribs : the upper 7 ribs whose Costal Cartilages join the sternum directly (vertebro-sternal ribs).
- (2) False ribs : the 8th, 9th & 10th ribs whose Costal Cartilages join each other & join the 7th Costal Cartilage forming the costal margin.
- (3) Floating ribs : the 11th & 12th ribs who end freely in the abdominal muscles.



II- Classification according to their relation to the vertebral Column:

- (1) Typical ribs : From 3 to 9 :
the posterior end (head) of each of them articulates with 2 thoracic vertebrae & the intervertebral disc inbetween.
 - (2) Non-typical ribs : 1, 2, 10, 11 & 12 :
the head of each non-typical rib articulates with the vertebra of the same number with the exception of the 2nd rib which articulates with 2 vertebrae (T₁ & T₂).
- N.B : the second rib is considered non-typical because its shaft differs from that of the typical ribs.

* General features about all ribs & Costal Cartilages :

- (1) The level of the 2 ends of the ribs : the level of the posterior or vertebral end of each rib lies at a higher level than its anterior end.
- (2) The direction of the ribs & Costal Cartilages : with the exception of the first 2 & the last 2 ribs, the ribs run downwards while their cartilages run upwards.
- (3) The length of the ribs : ribs & Costal Cartilages increase in length from the 1st rib to the 7th rib (the longest rib) then they decrease in length again.
- (4) The lateral projection : ribs increase in the lateral projection from the 1st rib to the 8th rib (the most laterally projecting one).
- (5) The obliquity of the ribs : ribs increase in obliquity from the 1st rib to the 9th rib (the most oblique one).

General features of the typical ribs 8

Each typical rib has 3 parts: ant-end, shaft & post-end.

(1) The anterior end:

is cup-shaped & articulates with the Costal cartilage

(2) The Shaft: is divided by the angle into:

(a) post. $\frac{1}{4}$ which is cylindrical &

(b) ant. $\frac{3}{4}$ which is flattened & has:

- 2 borders: an upper rounded border & a lower sharp border.

- 2 surfaces: an outer convex surface & an inner concave surface showing a costal groove in its lower part lodging the intercostal v., A. & N (from above downwards).

(3) The posterior end: formed of head, neck & tubercle

(a) the head: has 2 articular facets separated by a crest:

- the upper facet: articulates with the lower demifacet of the body of the vertebra above.

- the lower facet: articulates with the upper demifacet of the body of vertebra of the same number.

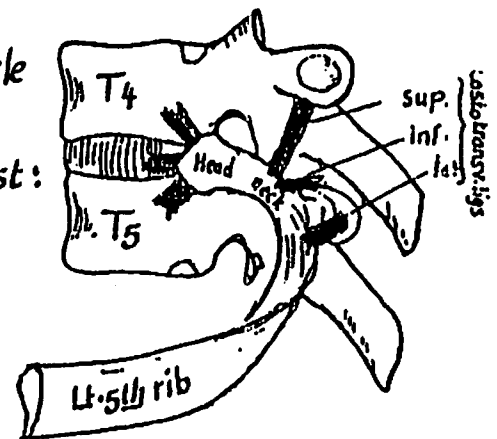
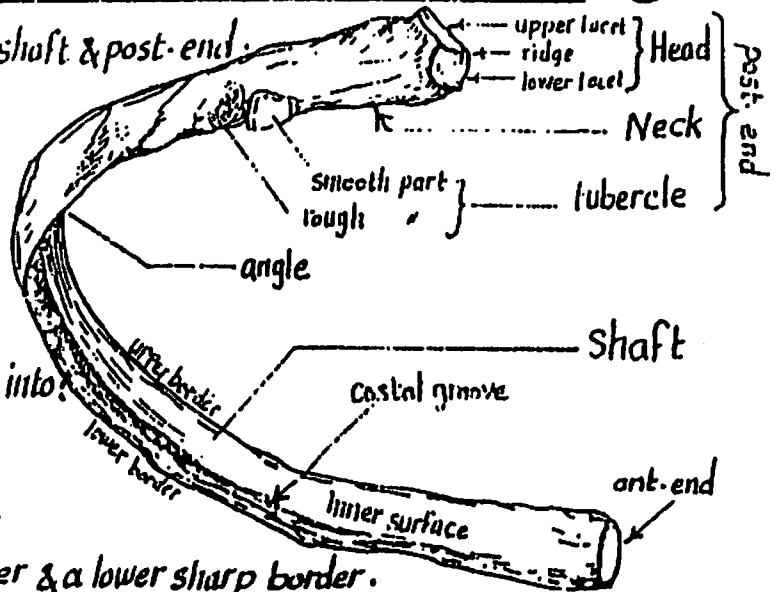
- the crest: articulates with the intervertebral disc between the 2 vertebrae.

(b) the neck: is the flattened part between the head & the tubercle. It is connected to the tr. processes of the vertebra of the same number & the vertebra above by the inf. & sup. costo transverse ligaments.

(c) the tubercle: is formed of 2 parts:

(1) medial smooth part: articulates with the transverse pr. of the vertebra of the same number.

(2) lateral rough part: gives attachment to the lat. costo-transverse lig. connecting it with the transverse process of the vertebra of the same number.



* Identification of the side of the typical rib (Rt. or Lt.):

- upwards: the rounded upper border of the shaft.

- medially: the shaft is concave medially.

- anteriorly: the ant-end has a cup-shaped concavity.

I- First rib:

Non-typical ribs

* It is the highest, flattest, strongest, most curved & most fixed rib.

* General features:

(1) Head : is small & has one facet which articulates with a circular facet on the body of the 1st thoracic vertebra.

(2) Neck : is rounded & slopes obliquely downwards.

(3) Tubercle : is prominent & coincides with the angle

(4) the Shaft : is flattened & has 2 surfaces & 2 borders:

- the upper surface : is rough & shows the following features:

(a) scalene tubercle : a prominent tubercle on the inner border (for the insertion of scalenus ant. muscle).

(b) groove for subclavian v. : crosses the upper surface in front of scalene tubercle.

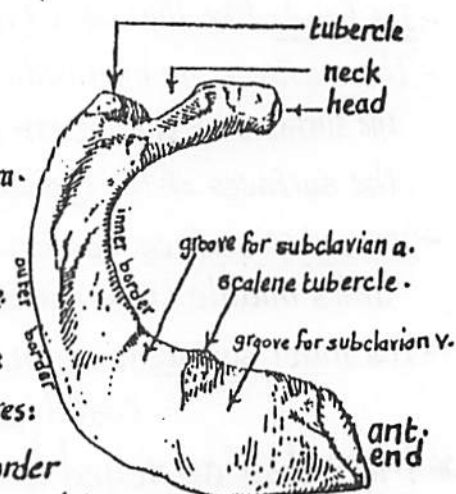
(c) groove for subclavian a. & lower trunk of brachial plexus : crosses the upper surface behind the scalene tubercle.

- the lower surface : is smooth, has no costal groove & is related to the pleura.

- the inner border : is concave & shows the scalene tubercle.

- the outer border : is convex & shows a rough impression (serrate tubercle).

(5) the anterior end : is thick, flattened & gives attachment to the 1st costal cartilage.



* Particular features of the 1st rib:

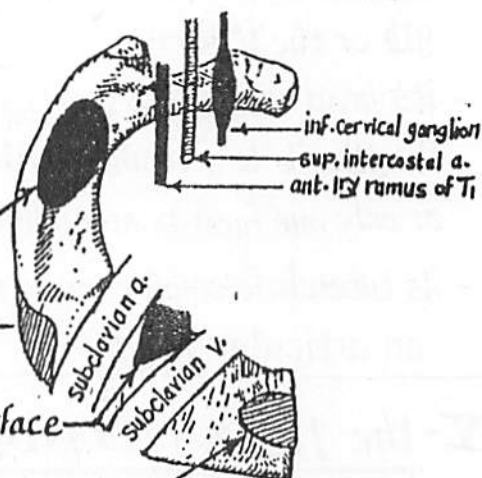
A-muscles attached : (4 "S" muscles) :

(1) Scalenus medius : inserted into post. part of upper surface

(2) Serratus ant. : arises from the middle of the outer border & the upper surface of the shaft

(3) Scalenus ant. : inserted into the scalene tubercle on the med. border & extends on the upper surface

(4) Subclavius m. : arises from the most ant. part of upper surface



B-relations of the neck of the 1st rib : 3 structures cross in front of the neck :

(1) the inferior cervical sympathetic ganglion : ----- most medially.

(2) the ant. primary ramus of the 1st thoracic n. : ----- most laterally.

(3) the superior intercostal a. ----- in between the previous 2.

* Identification of the side of the 1st rib (Rt. or Lt.)

- the upper surface is rough while the lower surface is smooth.

- the ant. end is large & cup-shaped while the post. end carries a small head.

- the outer border is convex while the inner border is concave.

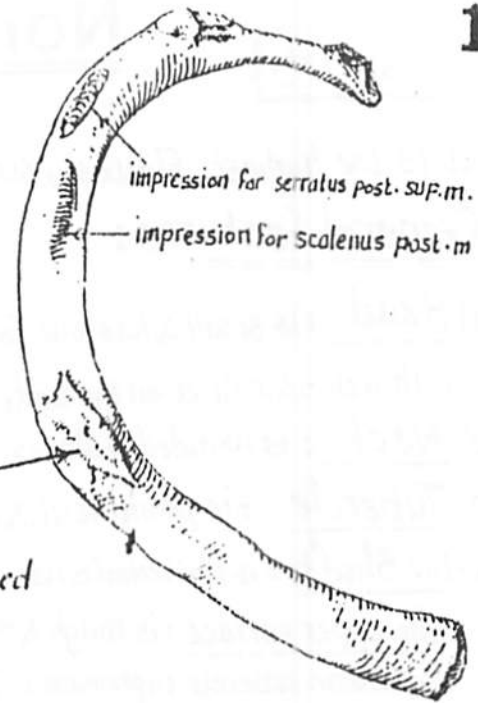
} if you put it correctly both the head & the ant. end will touch the table at the same time.

II- Second rib :

10

* General features :

- Length: twice as long as the 1st rib.
- Its head: like that of a typical rib.
- the surfaces are intermediate in direction between the surfaces of the 1st rib (upper & lower) and the surfaces of the typical rib (outer & inner).
- its outer surface carries a broad tubercle at its middle (for origin of serratus ant. m.).
- its inner surface is smooth & has poorly developed costal groove.

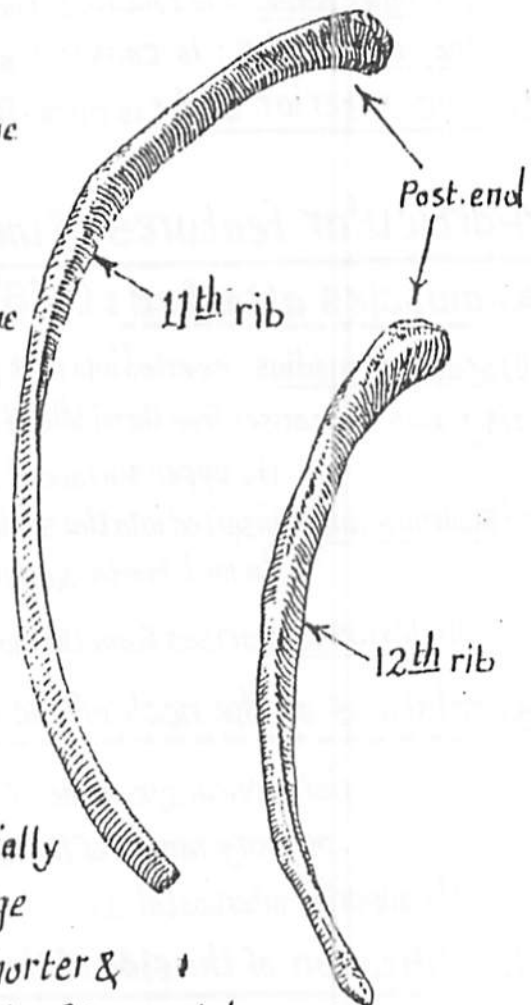


* Muscles attached to the 2nd rib:

- (1) Serratus ant. m.: arises from the broad tubercle on the middle of the outer surface.
- (2) Scalenus post. m.: inserted into the outer surface behind the origin of serratus ant.
- (3) Serratus post. sup.: " " " " " " " " insertion of scalenus post.

III The 10th rib:

- it is a transitional rib so it may look like the 9th or the 11th rib.
- its head: may have 2 articular facets like the 9th rib to articulate with T₉ & T₁₀ vertebrae or only one facet to articulate with T₁₀.
- its tubercle is small & may or may not have an articular facet.



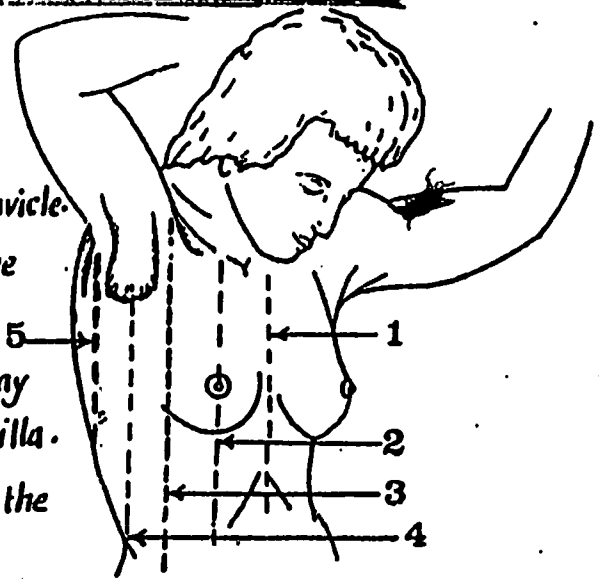
IV- the 11th & 12th ribs:

- * each of them has:
 - a large head with single articular facet
 - no neck, no tubercle, no angle
 - the inner surface is directed upwards & medially
 - the ant-end is pointed & tipped with cartilage
- * the 12th rib differs from the 11th in being shorter & having NO costal groove (the 11th rib has a faint costal groove).

* **CLINICALLY IMPORTANT POINTS RELATED TO RIBS** : see page 97.

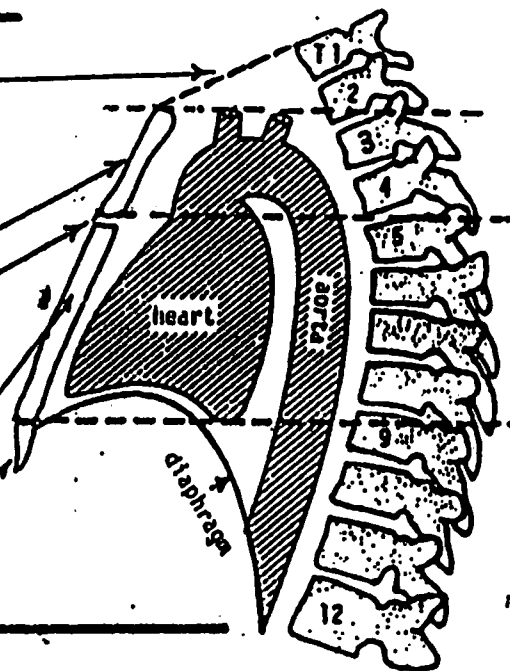
Lines of demarcation of thorax 11

- (1) Midsternal line: is the line in the median plane.
- (2) Midclavicular line: is the line running vertically downwards from the midpoint of clavicle.
- (3) Ant. axillary line: runs vertically downwards from the ant. axillary fold.
- (4) Midaxillary line: runs vertically downwards midway between the ant. & post. folds of axilla.
- (5) Post-axillary line: runs vertically downwards from the post. fold of axilla.
- (6) the scapular line: a vertical line on the post-thoracic wall passing through inf. angle of scapula.



The levels & planes of the thorax

- (1) the plane of the inlet of thorax: extends from the upper border of manubrium to the upper border of the body of the 1st thoracic vertebra.
- (2) the manubrium: lies opposite T3 & T4 vertebrae.
- (3) the plane of the sternal angle: extends from lower border of manubrium to the lower border of T4 vertebra.
- (4) the body of sternum: lies opposite T5-8 vertebrae.
- (5) the xiphoid process: lies opposite T9 vertebra.

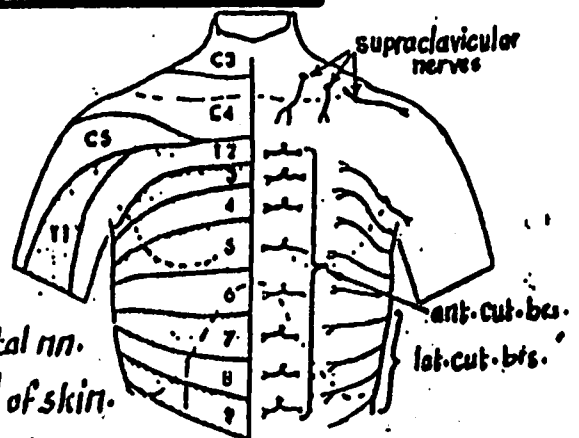


Cutaneous innervation of the Chest Wall

- (A) Above the level of the sternal angle: the skin of the ant. chest wall is supplied by the supraclavicular nerves (C3, 4).
- (B) Below the level of the sternal angle: the skin of the ant. chest wall is supplied by the lat. & the ant. cutaneous branches of intercostal nn.

N.B: the branches of each n. supply an oblique band of skin.

- (C) the skin of the post. chest wall is supplied by the post. rami of the thoracic nerves.



The Intercostal Spaces

12

* Definition: the intercostal space is the space between each 2 successive ribs.

There are 11 intercostal spaces between the 12 ribs on either side & each space lies below the numerically corresponding rib i.e the 1st space lies below the 1st rib.

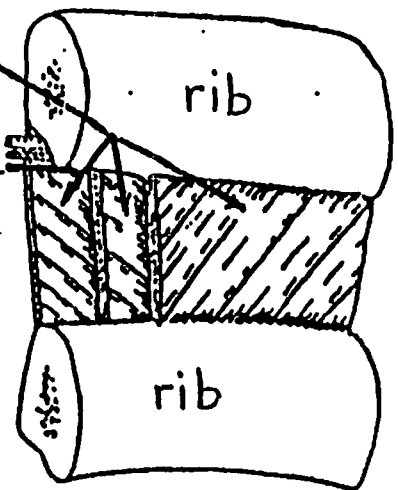
* Structure: each intercostal space contains:

(A) Intercostal muscles & membranes arranged in 3 layers.

(B) a neurovascular bundle consisting of: (1) intercostal V.

(2) intercostal a.

(3) intercostal n.



(A) Intercostal Muscles

* they are arranged in 3 layers in each space:

(1) outer layer: the external intercostal muscle.

(2) middle " : the internal " " "

(3) inner layer: the transversus thoracis muscle: it is an incomplete layer formed of 3 separate muscles: (a) Sternocostalis m. (b) innermost intercostal & subcostalis m.

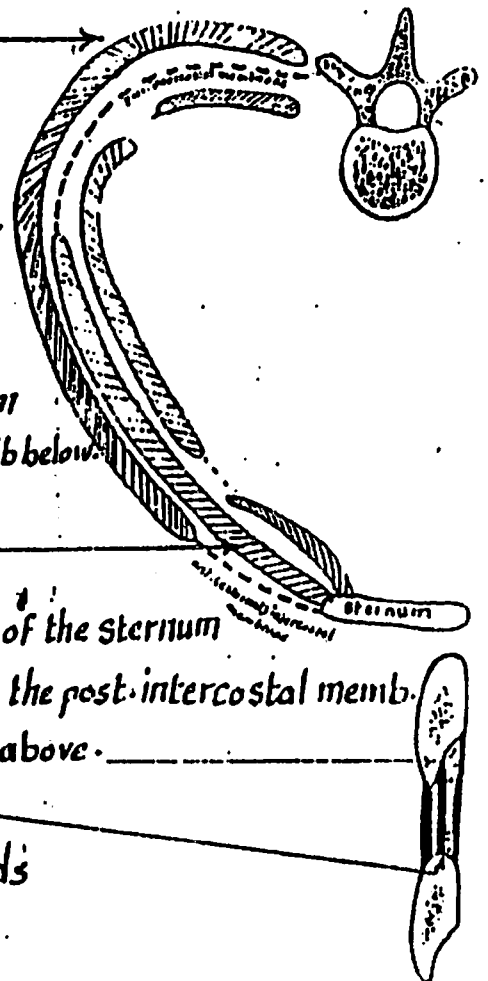
(1) External intercostal muscle

* Extension: it begins posteriorly at the tubercle of the rib & ends anteriorly at the Costo-chondral junction by becoming the ant. intercostal membrane extending to sternum.

* Origin: from the lower border of the rib above.

* Insertion: into the upper border of the rib below.

* direction of fibres: obliquely downwards & forwards: from the lower border of the rib above to the upper border of the rib below.



(2) Internal intercostal muscle

* Extension: it begins anteriorly at the lateral margin of the sternum & ends posteriorly at the angle of the rib by becoming the post. intercostal memb.

* Origin: from the floor of the costal groove of the rib above.

* Insertion: into the upper border of the rib below.

* Direction of fibres: obliquely downwards & backwards

(3) the transversus thoracis muscle

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* It is formed of 3 separate muscles :

(A) Innermost intercostal m.

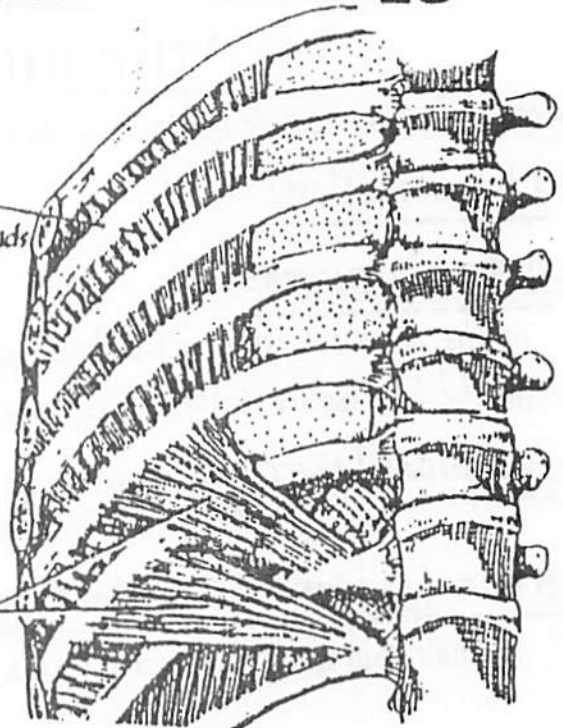
* Extension : begins in front of the midaxillary line & extends backwards to end at the angle of the rib.

* Origin : upper border of costal groove of the rib above.

* Insertion : into the upper border of the rib below.

* direction of fibres : as the internal intercostal m.

* N.B : the neurovascular bundle passes between the internal intercostal & the innermost intercostal m.



(B) Subcostalis muscle :

* It is formed of thin muscular bands lying at the post. part of the inner surface of the chest wall mainly in the lower part.

* Origin : each band arises from the inner surface of the rib above

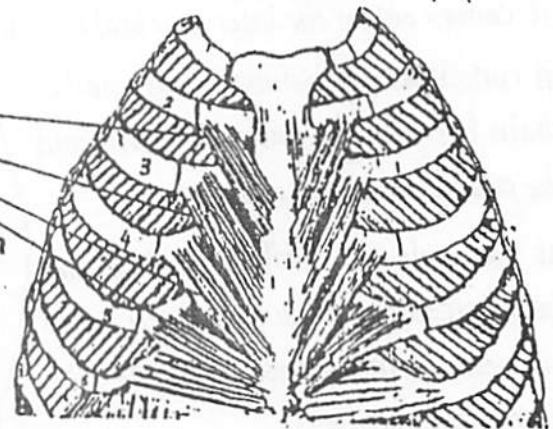
* Insertion : " " Crosses one or 2 ribs to be inserted into upper border of the 2nd or the third rib below.

(C) Sternocostalis muscle :

* It lies in the ant. part of the inner surface of the chest wall extending from the back of sternum to the costal cartilages from 2 to 6

* Origin : 4 or 5 slips from the post. surface of the lower $\frac{1}{2}$ of the sternum.

* Insertion : the slips run upwards & laterally to be inserted into the inner surfaces of the Costal Cartilages from the 2nd to the 6th.



* N. Supply of the intercostal muscles :

they are supplied by the corresponding intercostal nerves & their collateral branches.

* Action of the intercostal muscles :

(1) the external intercostals elevate the ribs during inspiration.

(2) the internal intercostals & transversus thoracis depress the ribs & costal cartilages during expiration.

(3) all muscles prevent the inward suction of the intercostal spaces during inspiration or their outward puffing during expiration.

Nerve supply of thoracic wall 14

"the intercostal nerves"

* They are the anterior 1st rami of the thoracic nerves. There are 11 intercostal & one subcostal nerve.

* Classification:

- 2 special nerves:

(a) the 1st nerve: most of its fibres ascend to join the brachial plexus.

(b) the last (subcostal) nerve: runs all its course in the abdominal wall.

- 5 typical Intercostal nerves: From the 2nd to the 6th nerves: they run all their course in the thoracic wall.

- 5 non-typical intercostal nerves: From the 7th to the 11th nerves: they run part of their course in the thoracic wall & part in the abdominal wall.

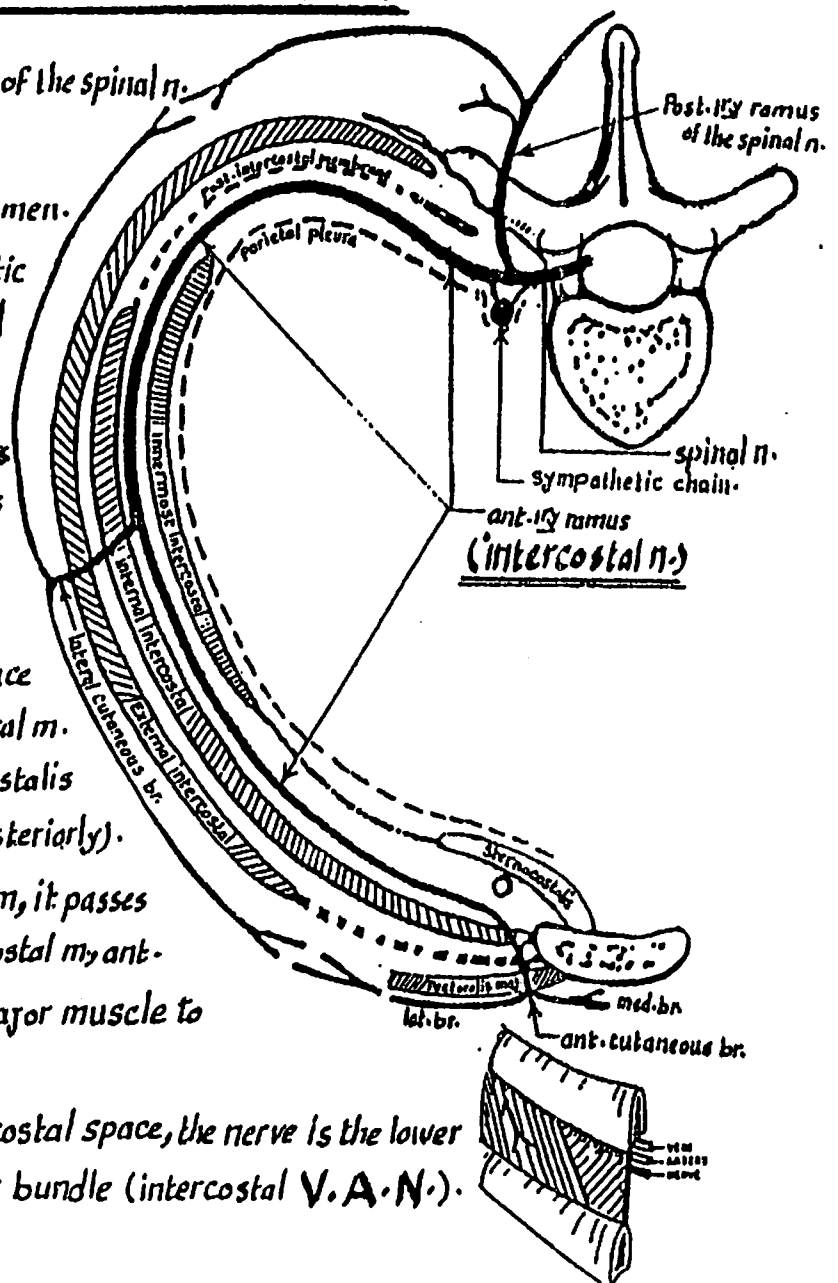
Anatomy of a typical intercostal nerve (2-6)

- Origin: it arises as the ant. 1st rami of the spinal n.

- Course & relations:

- (1) it comes out of the intervertebral foramen.
- (2) it runs laterally behind the sympathetic chain between the parietal pleura and the post. intercostal membrane.
- (3) at the angle of the rib, the nerve enters the intercostal space running forwards between the innermost & the internal intercostal muscles.
- (4) at the ant. part of the intercostal space it lies between the internal intercostal m. (anteriorly) & parietal pleura, sternocostalis m. & internal mammary vessels (posteriorly).
- (5) about 1/2 an inch lateral to the sternum, it passes forwards, piercing the internal intercostal m., ant. intercostal membrane & pectoralis major muscle to end as the ant. cutaneous nerve.

N.B: throughout its course in the intercostal space, the nerve is the lower structure of the neurovascular bundle (intercostal V.A.N.).



* Branches of the typical intercostal n. :

(1) Ganglionic branches : each n. gives a white ramus communicans (preganglionic) to, and receives a grey ramus communicans (postganglionic) from the corresponding ganglion of the sympathetic chain.

(2) Collateral branch (motor) : runs along the upper border of the rib below & supplies the intercostal muscles.

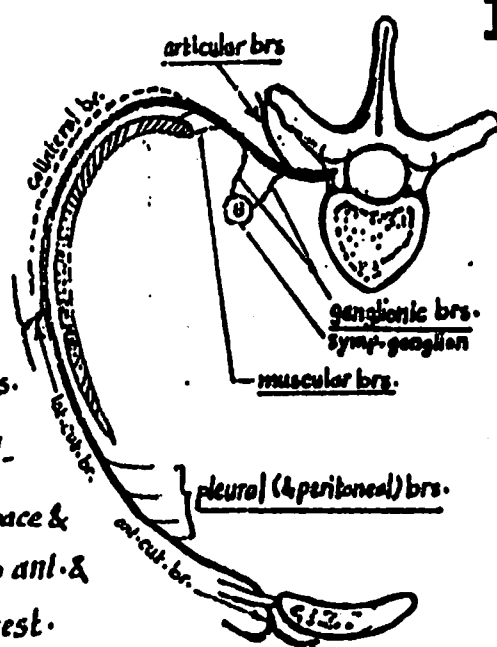
(3) lateral cutaneous br. : passes laterally in the mid-axillary line piercing the muscles of the intercostal space & serratus ant. m. to reach the skin where it divides into ant. & post. branches supplying the skin of the side of the chest.

(4) Anterior cutaneous br. it is the termination of the intercostal n. It divides into med. & lat. branches which supply the skin of the front of the chest.

(5) muscular branches : from the main n. & its collateral br. to supply the intercostal muscles.

(6) Pleural & peritoneal branches : to the parietal layers of these serous membranes.

(7) articular branches : to the joints of the ribs.



N.B: the intercostobrachial n. : is the lat. cutaneous br. of the 2nd intercostal n. which, unlike the others, does not divide into ant. & post. branches but passes laterally to supply the axilla.

* CLINICALLY IMPORTANT POINTS RELATED TO INTERCOSTAL NERVES : see page 97.

The non- typical intercostal n.

"thoraco- abdominal nerves"

* They are the lower 5 intercostal nerves (from 7 to 11).

* They run the same course as the typical intercostal nerves till they reach the ant. ends of the intercostal spaces

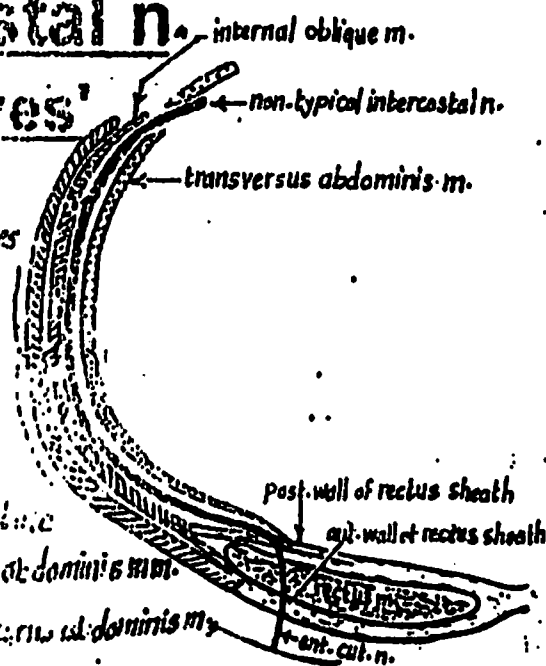
* Course & relations in the ant. abdominal wall :

(1) they enter the ant-abd-wall by passing between the fibers of origin of the transversus abdominis m.

(2) then they run forwards & medially in the retro-rectus plane of the ant. abd-wall between internal oblique & transversus abdominis m.

(3) each n. ends by piercing the post-wall of rectus sheath, the transversus abdominis m., & the ant-wall of the rectus sheath to become the ant. cut. n.

* Branches : the same as those of the typical nerves. In addition it gives branches to the abdominal muscles & supplies the skin of the ant. abd-wall.



Arterial supply of the thoracic wall **16**

"the Intercostal arteries"

- * The intercostal spaces are supplied by 2 sets of intercostal arteries : $\begin{cases} \text{ant. intercostal aa.} \\ \text{post.} \end{cases}$

(A) The anterior intercostal arteries:

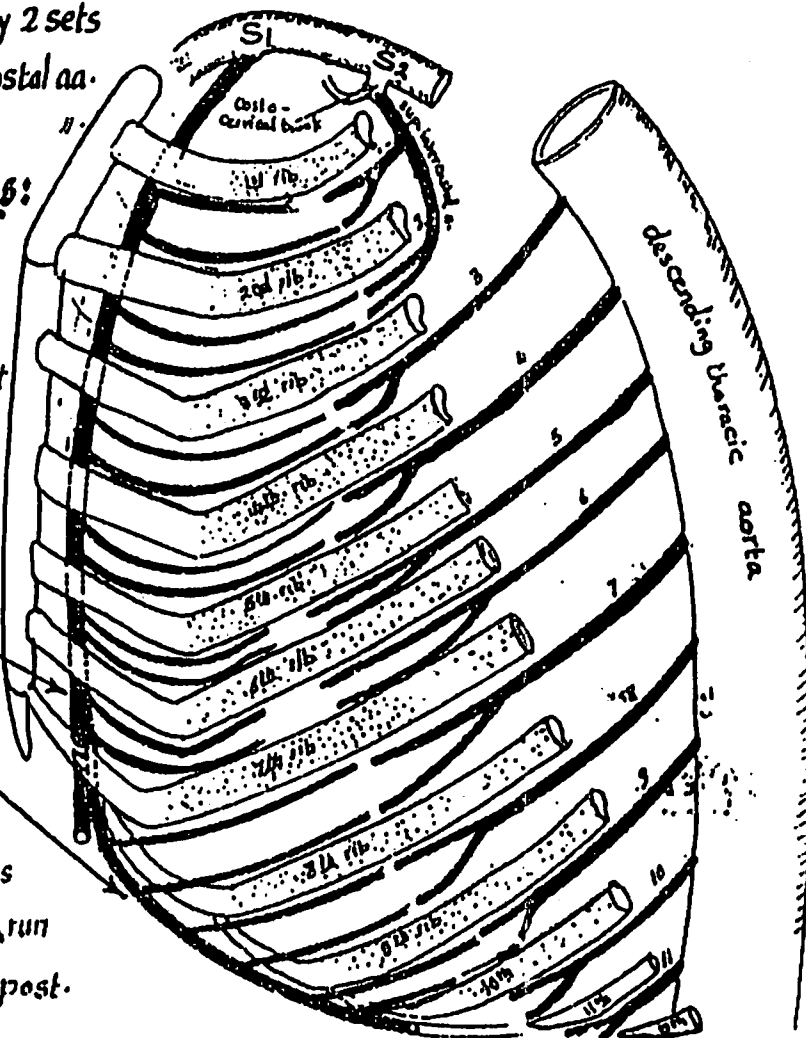
- * number: there are 2 ant. intercostal aa. in each of the upper 9 intercostal spaces (no ant. intercostal aa. are present in the 10th & 11th spaces).

* Origin:

- in the upper 6 spaces, the arteries are branches of the Internal mammary a.
- in the 7th, 8th & 9th spaces, the arteries are branches of the musculo-spiral a.

* Course:

the 2 arteries of each of the upper 9 spaces enter the intercostal space at its ant. end & run laterally to end by anastomosing with the post. intercostal a. & its collateral branch.



(B) The posterior intercostal arteries:

- * Number: there is one posterior intercostal a. in each of the 11 intercostal spaces.

* Origin:

- the arteries of the 1st & 2nd spaces are branches of the sup. intercostal a. which is a branch of the costocervical trunk arising from the 2nd part of subclavian a.
- the arteries of the remaining intercostal spaces (from 3 to 11) are branches of the descending thoracic aorta.

* Course:

- each post. intercostal a. enters the intercostal space at its post. end. It runs laterally then forwards in the costal groove below the intercostal vein.
- it gives a collateral branch which runs along the upper border of the rib below.
- the post. intercostal & its collateral br. end by anastomosing with the 2 ant. intercostal arteries.

Internal mammary (Internal thoracic) artery 17

* Origin: in the root of the neck from lower aspect of 1st part of subclavian artery about 2 cm above the sternal end of the clavicle.

***Course:**

- (1) it enters the thorax by passing behind the clavicle, crossing in front of the cervical pleura & apex of lung.
- (2) it descends vertically behind the upper 6 costal cartilages lying one cm lat. to the lat. border of the sternum
- (3) it is accompanied medially by the internal mammary v. — down to the 3rd intercostal space, below this level it is accompanied by 2 venae comitantes (one on each side) — which will unite to form the internal mammary vein.

* Termination : opposite the 6th intercostal space by dividing into 2 terminal branches:

* Relations:

- (A) Anteriorly: (i) sternal end of the clavicle.

- (2) internal jugular & brachiocephalic veins.

- (3) the upper 6 costal cartilages & the intervening intercostal muscles.

- (4) phrenic n. (crosses the upper part of the artery from lat. to med.).

(B) Posteriorly: pleura, but separated from it by (a) thick fascia (above the level of 3rd cartilage).

- (b) sternocostalis m. (below u m s n u n n)

(c) Medially : internal mammary v. (above the level of the 3rd costal cartilage).

* Branches : (4 P_s + S M S M):

- (ii) Pair of anterior intercostal arteries to each of the upper 6 intercostal spaces.

(2) Perforating brs.: which pierce the upper 6 spaces with the ant. cutaneous brs. of the corresponding intercostal nerves. Those of the 2nd, 3rd & 4th spaces supply the mammary gland before reaching the skin.

(3) Pericardiophrenic a.: descends in company with the phrenic n. to supply pericardium, diaphragmatic pleura & upper surface of the diaphragm.

(4) Pericardial brs.: to upper part of pericardium.

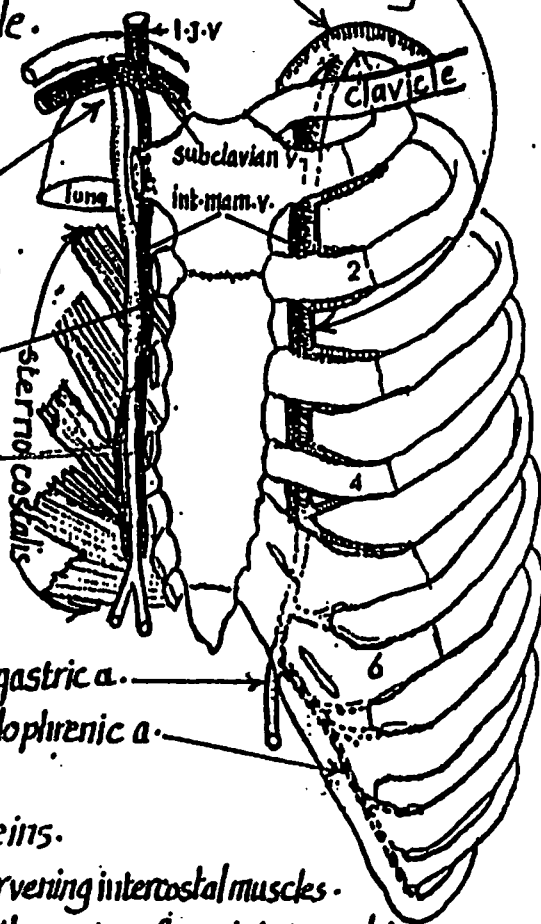
(5) Sternal brs.: to sternocostalis muscle & back of the sternum.

(6) Mediastinal brs.: to the contents of ant. mediastinum (L.Ns & remnants of thymus gland).

(7) Musculophrenic a. (one of the 2 terminal brs.): it runs along the costal margin to supply the diaphragm. It gives a pair of ant. intercostal aa. to the 7th, 8th & 9th spaces.

(8) Sup. epigastric a. (the other terminal br. :

- it runs downwards traversing the diaphragm (between the sternal & costal origins) to enter the rectus sheath in the ant. abdominal wall. Its subsequent course is described in the abdomen.



Venous drainage of chest wall 18

(the Intercostal veins)

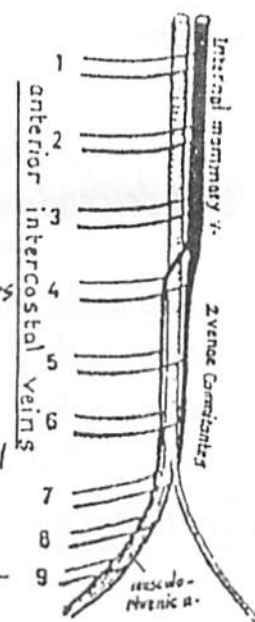
(A) Anterior intercostal veins: correspond to the ant. intercostal arteries i.e 2 veins in each space.

- the ant. intercostal vv. of the 9th, 8th & 7th spaces: join the venae comitantes of the musculophrenic a.

- " " " " " 6th, 5th & 4th spaces: join the venae comitantes of the internal mammary a.

- " " " " " 3rd, 2nd & 1st spaces join the internal mammary v.

N.B: the venae comitantes of the int. mammary a. unite opposite the 3rd intercostal space to form the internal mammary v. which ends in the innominate v.



(B) Posterior intercostal veins:

- there are 11 post. intercostal veins on each side (one in each space).

- they have different arrangement on both sides:

I- On the right side:

(1) the 1st vein ends in the Rt. innominate vein.

(2) the 2nd, 3rd & 4th veins: unite to form Rt. sup. intercostal v. which ends in the arch of azygos v.

(3) the remaining veins (from the 5th to the 11th & the subcostal v.): end separately in the azygos vein.

II- On the left side:

(1) the 1st vein: ends in the Lt. innominate v.

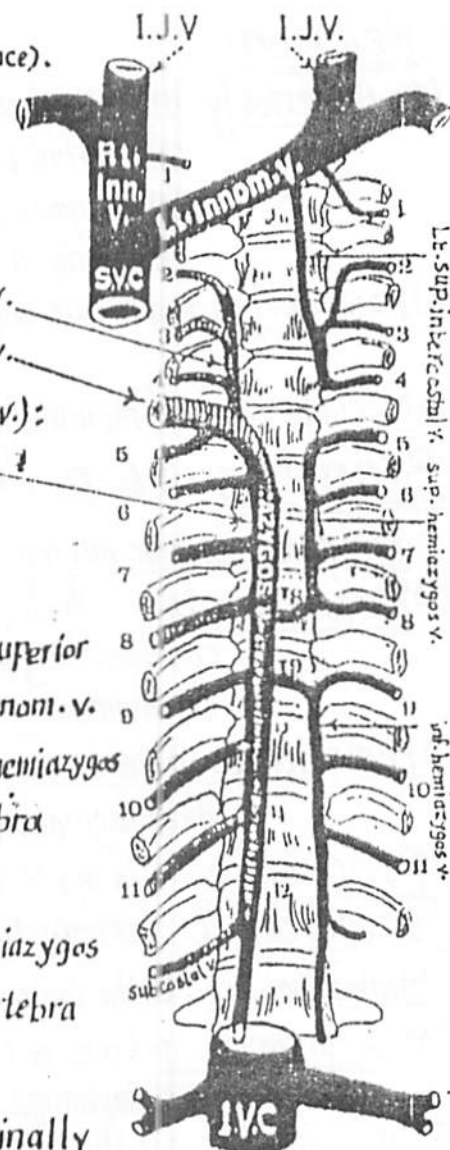
(2) the 2nd, 3rd & 4th veins: unite together to form the Lt. superior intercostal v. which opens into Lt. innom. v.

(3) the 5th, 6th, 7th & 8th veins: end in the superior (accessory) hemiazygos vein which turns to the right crossing the body of T8 vertebra to open into the azygos vein.

(4) the 9th, 10th, 11th & the subcostal vein end in the inf. hemiazygos vein which turns to the right crossing the body of T9 vertebra to open into the azygos vein.

N.B: (1) all the venous blood of the thoracic wall drains finally into the superior vena cava (S.V.C).

(2) for the detailed anatomy of the S.V.C, Azygos & hemiazygos veins: see pages: 71, 72, 73.



The thoracic inlet

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* Boundaries:

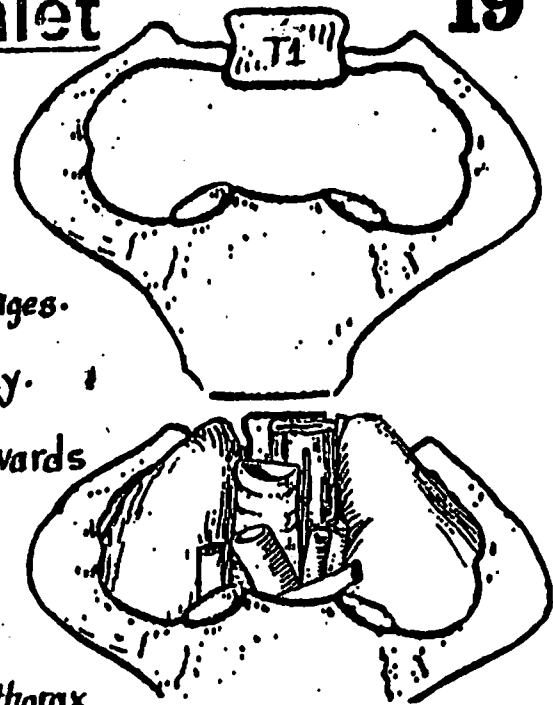
- anteriorly : the upper border of the manubrium.
- posteriorly: the body of the 1st thoracic vertebra.
- on either side: the 1st pair of ribs & their costal cartilages.

* Shape & Size: it has the shape & size of a kidney.

* Its plane: is oblique, sloping downwards & forwards

* Important structures passing through it:

- the median part of the thoracic inlet transmits the structures that pass inbetween the neck & the thorax.
- on each side of these structures, the apex of the lung projects for a short distance covered by the cervical pleura & a tent-shaped strong fascial layer called suprapleural membrane.
- the following are the important structures passing through the thoracic inlet :



(A) Viscera	(B) Arteries	(C) Veins & Lymphatics	(D) Nerves
(1) Trachea	(1) Innominate a.	(1) Rt. Innominate v.	(1) Rt. & Lt. Vagus
(2) Oesophagus	(2) Lt. Common carotid a.	(2) Lt. " "	(2) Rt. & Lt. phrenic
(3) apices of Rt. & Lt lung	(3) Lt. subclavian a.	(3) thoracic duct.	(3) Rt. & Lt. symp. chain.
			(4) Lt. recurrent laryngeal n.
			(5) Rt. & Lt. ant. rami of 1st thoracic nerves

The Suprapleural membrane (Sibsons fascia)

* It is the upper thickened part of the endothoracic fascia forming a tough membrane stretching across the inlet of thorax on either side.

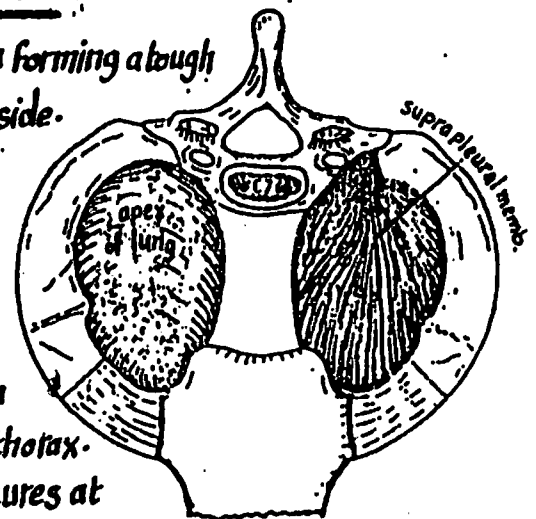
* Shape: triangular, having an apex & a base.

* Attachments:

- the apex is attached to the tr. process of C7 vertebra.
- the base: is attached to the med. border of the 1st rib & 1st costal cartilage. Medially, it blends with the fascia investing the structures passing inbetween the neck & thorax.

* Functions: (1) it prevents the inward suction of the structures at the root of the neck with every inspiratory movement.

(2) it prevents the upward puffing of apex of lung during expulsive expiratory efforts.



The thoracic outlet

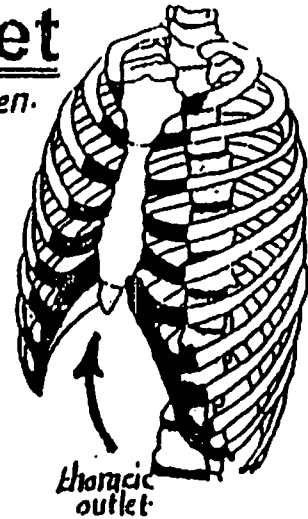
20

* It is the lower opening of the thoracic cage at its junction with abdomen.

* Boundaries:

- anteriorly : the xiphoid process.
- posteriorly : T12 vertebra & the 11th & 12th ribs of both sides.
- on either side : the costal margin (7th, 8th, 9th & 10th costal cartilages fused together).

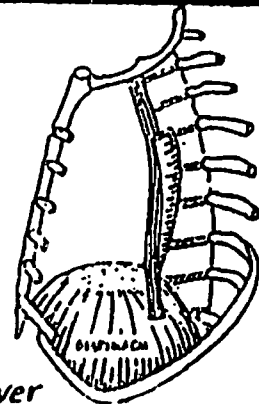
* the thoracic outlet is closed by the diaphragm which is pierced by many structures on their way to or from the abdomen.



The Diaphragm

* Nature & shape:

- it is a large dome-shaped musculo-tendinous partition which separates the thoracic cavity from the abdominal cavity.
- its upper surface is convex towards the thoracic cavity while its lower surface is concave towards the abdominal cavity.
- its right side (called Rt. cupola) bulges higher up than its left side (Lt. cupola) due to the upward bulge of the underlying Rt. lobe of the liver.



* Origin of the diaphragm:

- the peripheral part of the diaphragm takes origin from the circumference of the outlet of the thorax. The origin is divided into 3 parts:

(1) Sternal origin : by 2 slips from the back of the xiphoid process.

(2) Costal origin : by slips from the inner surfaces of the lower 6 costal cartilages of both sides.

(3) Vertebral origin : by 2 muscular bands (called Rt. & Lt. crura) and from 5 arched ligaments (one median; 2 medial & 2 lateral) called arcuate ligaments:

(a) the Rt. crus : arises from the bodies of the upper 3 lumbar vertebrae.

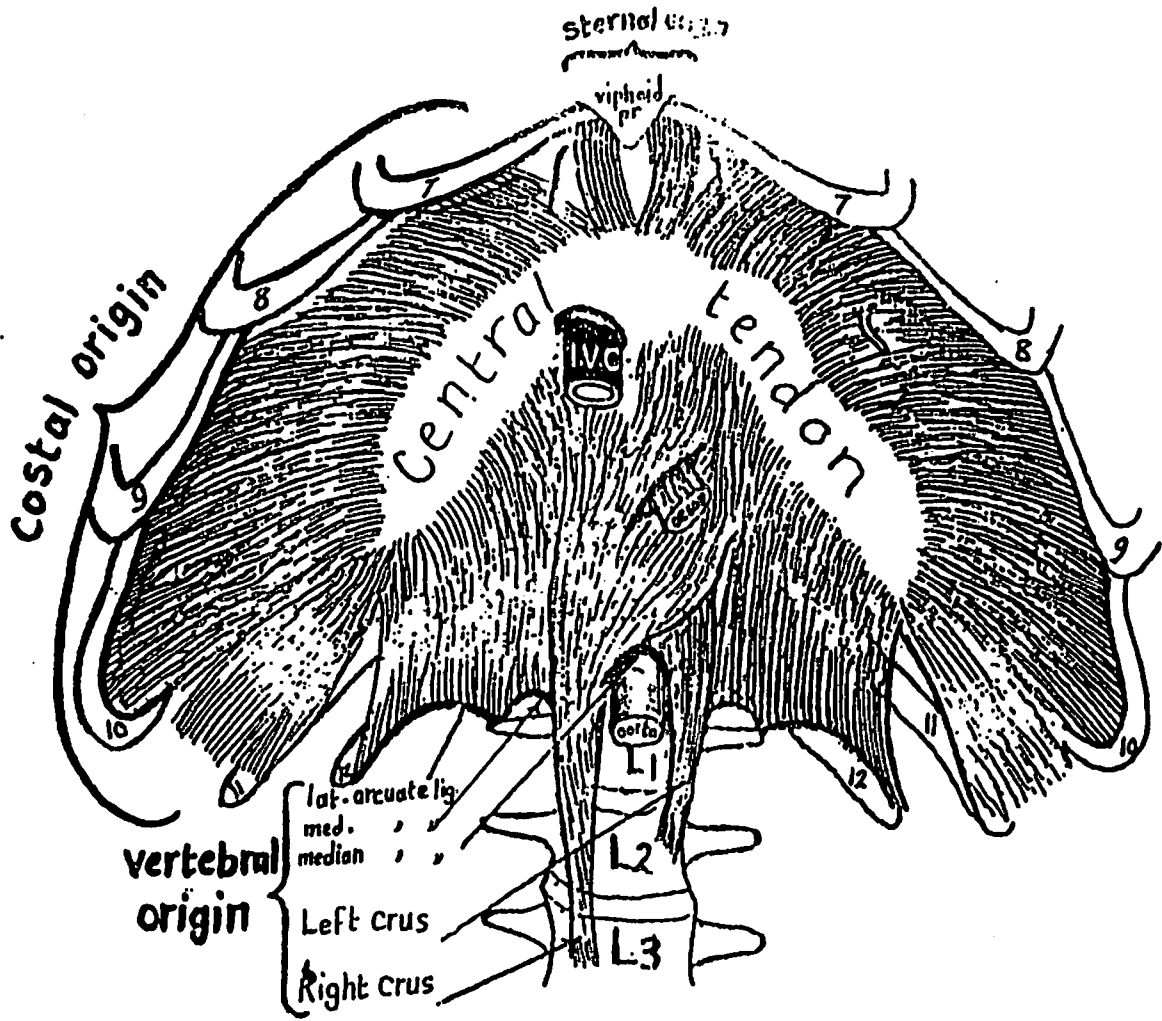
(b) the Lt. crus : " " " " " " upper 2 " "

(c) the median arcuate lig. : is a tendinous arch that connects the 2 crura together.

(d) each medial " " (Rt. & Lt.) : is a tendinous arch that connects the crus with the tip of the transverse process of the 1st lumbar vertebra.

(e) each lateral arcuate lig. (Rt. & Lt.) : is a tendinous arch which connects the tip of the tr. process of L1 vertebra to the last rib.

* Insertion : the fibres of the sternal, costal & vertebral parts converge to be inserted into a crescentic-shaped central tendon which is more ant. than post. in position.



*** Nerve Supply :**

- (1) the phrenic nerves (motor).
- (2) branches from the lower 6 or 7 intercostal nerves : sensory to the periphery of diaphragm.

*** Action :** the diaphragm is the main muscle of inspiration. Its contraction leads to its descent & increase in the vertical diameter of the thoracic cavity.

*** the Major foramina of the diaphragm :**

- Vena caval : Voice
- Oesophageal : OF
- Aortic : America

Opening	Vena Caval opening	Oesophageal O.	Aortic opening
vertebral level	T8	T10	T12
Position	1" to the Rt. of middle line piercing the central tendon.	1" to the Lt. of middle line piercing the Rt. crus of diaphragm.	in the middle line behind the median arcuate lig. of diaphragm.
Structures passing	(1) the I. V. C (2) Rt. phrenic n. (3) lymphatics from the liver to thoracic L.Ns	(1) Oesophagus (2) the ant. & post. gastric nn. (originally Lb & Rt. Vagi). (3) oesophageal br. of Lt. gastric a.	(1) descending aorta (2) Azygos vein. (3) thoracic duct.

* Other structures passing through the diaphragm: S, S, S

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- (1) the **S**planchnic nerves : pierce the crura of the diaphragm.
- (2) the **S**ympathetic trunks : pass behind the med. arcuate lig.
- (3) the **S**up. epigastric a. : passes between the slip of sternal origin & the 1st slip of costal origin.

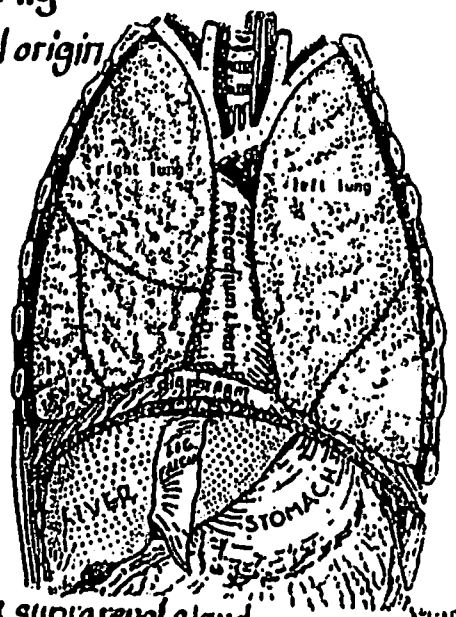
* Relations of the diaphragm:

A-Upper surface:

- (1) its central tendon is related to the pericardium & heart.
- (2) the Rt. cupola is related to Rt. pleura & base of Rt. lung.
- (3) the Lt. " " " " Lt. " " " " Lt. " " " " Lt. " " " "

B-Lower surface:

- (1) its Rt. cupola is related to Rt. lobe of liver, Rt. kidney & suprarenal gland.
- (2) its Lt. cupola " " " " Lt. lobe of liver, fundus of stomach, Lt. kidney & suprarenal gland.



The Thoracic Cavity

(A) Lining of thoracic cavity: "The endothoracic fascia"

* definition: it is loose fibrocellular tissue that lines the thoracic wall & covers the mediastinal structures.

* extensions:

- above: it is thickened to form the suprapleural membrane. (see page 191).
- below: it covers the dome of the diaphragm.
- medially: the fasciae of both sides meet in the middle region to form the loose connective tissue of the mediastinum.
- laterally: it forms a fibro-elastic membrane which lines the thoracic wall binding the parietal pleura to the inner surfaces of the ribs & costal cartilages.

(B) Subdivisions: the thoracic cavity can be divided into:

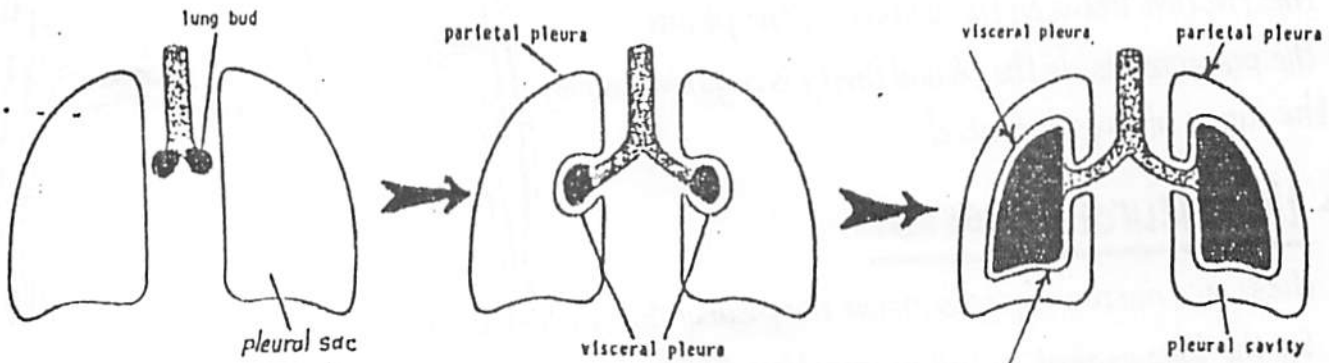
I- 2 pleural cavities: one on each side containing a lung.

II- the Mediastinum: a median partition between the 2 pleural cavities containing a number of structures.

The Pleura

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*** Definition:** it is a completely closed sac which is invaginated by the lung from its medial aspect.



* Subdivisions of the pleura:

(1) Visceral pleura: it is the part investing the lung & is closely adherent to it.

(2) Parietal pleura: it is the part lining the thoracic cavity & has the following parts:

(a) Cervical part: the part bulging up through the thoracic inlet

(b) Costal : the part lining the ribs & intercostal spaces

(c) Mediastinal part: covering the side of mediastinum

(d) diaphragmatic : covering upper surface of diaphragm

(3) Pulmonary ligament:

- the parietal pleura covering the mediastinum (mediastinal pleura)

is continuous with the visceral pleura covering the lung

by a tubular sheath or sleeve of pleura.

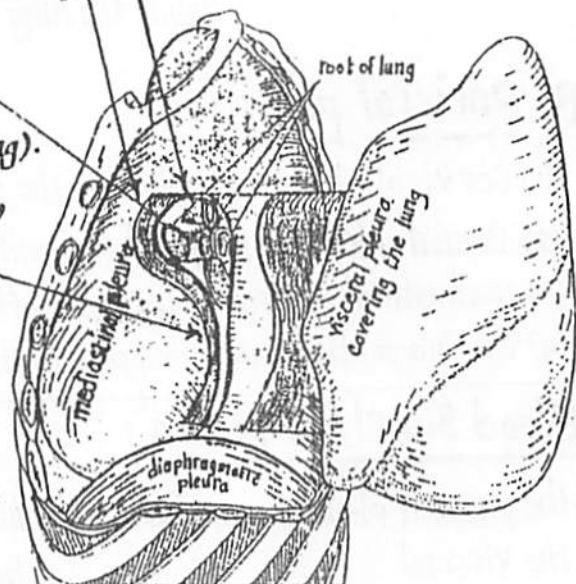
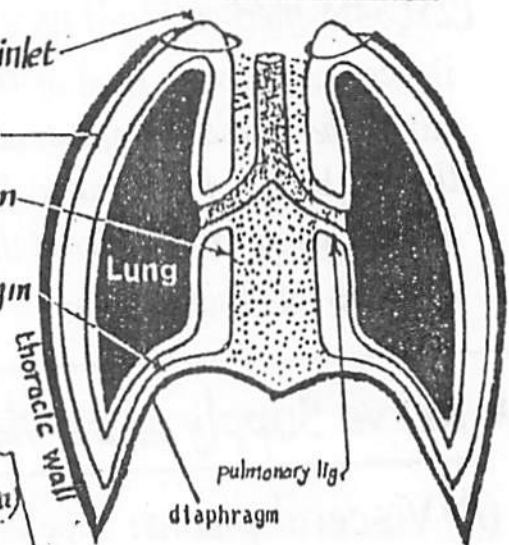
- the upper part of this sheath contains the structures that pass to & from the lung (root of lung).

- the lower part of this tubular sheath, being empty, is collapsed & known as the pulmonary ligament that extends down to the diaphragm.

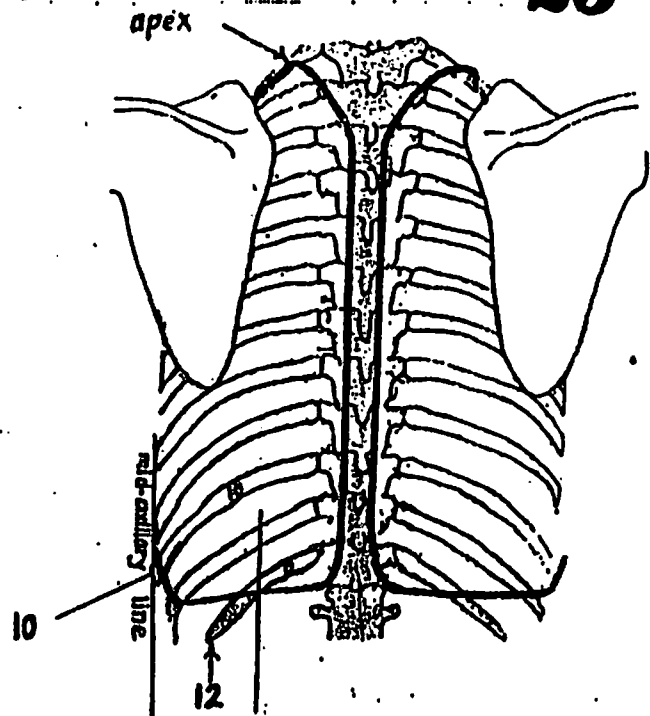
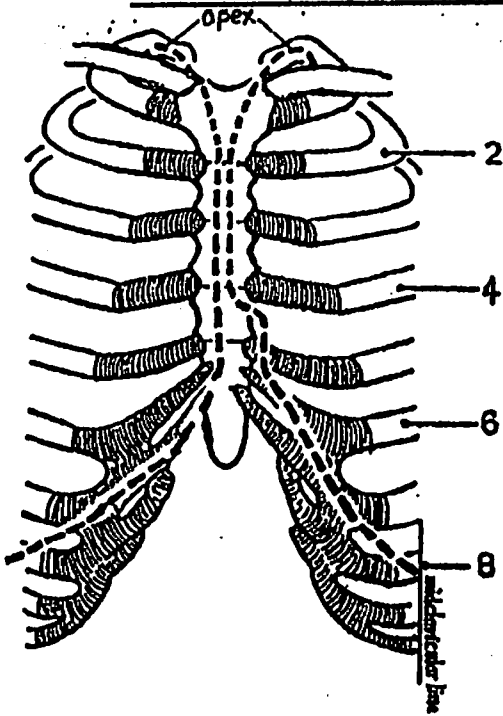
Significance of the pulmonary ligament:

(1) it allows free up & down movements of the root of the lung during respiratory excursions.

(2) it allows a dead space for the dilatation of the lower pulmonary v. during increased venous return from the lung.



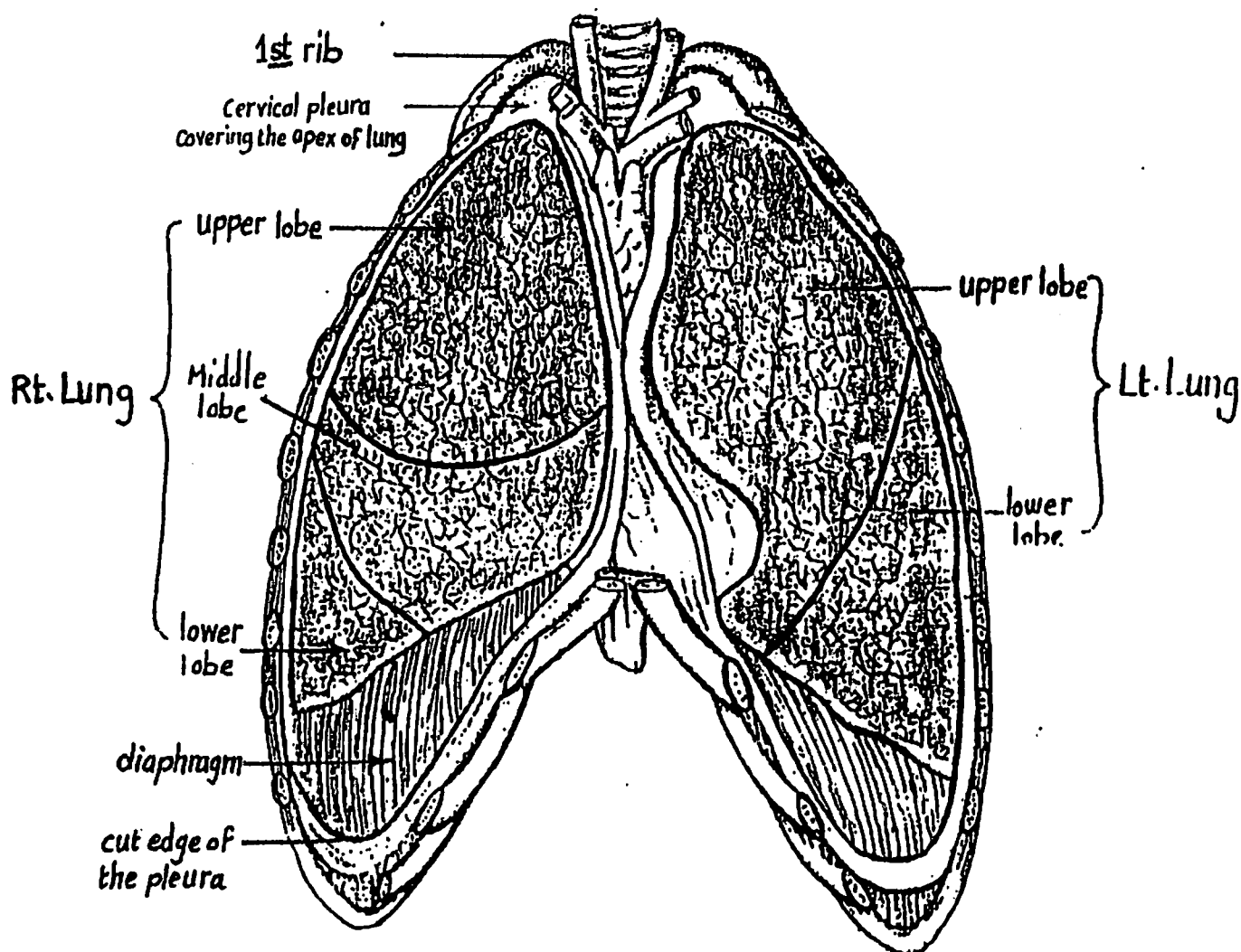
Surface anatomy of the pleura 25



	Right pleura	Left Pleura
1-Apex (cervical pleura)	represented on both sides by a curved line (convex upwards) starting from the point of junction between the middle $\frac{1}{3}$ & medial $\frac{1}{3}$ of the clavicle & passing downwards & medially to a point at the sterno clavicular joint.	
2-Ant. border	<p>(1) it begins from the point of the sterno-clavicular joint & passes downwards & medially to meet its fellow of the Lt. side in the middle line at the sternal angle.</p> <p>(2) the ant. border of the Rt. pleura descends vertically (without deviation) close to the middle line till the level of the 6th Costal cartilage where it ends.</p>	<p>(1) it begins from the point of the sterno-clavicular joint & passes downwards & medially to meet its fellow of the Rt. side in the middle line at the sternal angle.</p> <p>(2) the ant. border then descends vertically to the level of the 4th costal cartilage</p> <p>(3) then it descends close to the left margin of the sternum from the 4th c. cartilage to the 6th c. cartilage where it ends</p>
3-Inf. border	<p>represented on both sides by a line starting at the 6th costal cartilage (where the ant. border ends) & passing backwards around the Chest wall crossing:</p> <ul style="list-style-type: none"> - the 8th rib in the midclavicular line. - the 10th rib in the midaxillary line. - the 12th rib opposite the lat. border of sacrospinalis m. then extends to the level of the 12th thoracic spine where it ends. 	
4-post. border	Is represented on both sides by a vertical line starting close to the 12 th thoracic spine (where the Inf. border ends) & ascending upwards alongside the vertebral column to end at the point of the apex of pleura.	

The Lung

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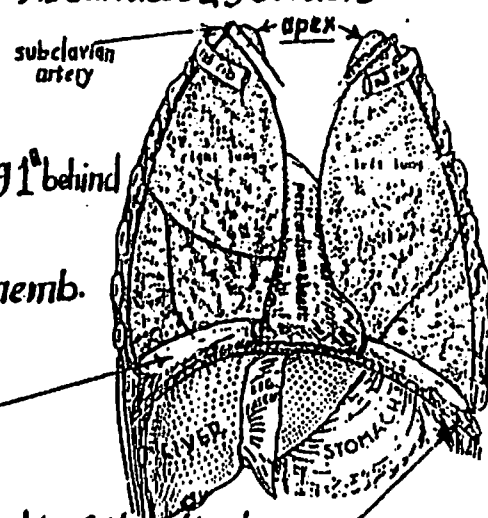


* The lungs are the organs of exchange of gases between blood & atmospheric air.

* **Shape**: each lung looks like half cone with an apex, base, 2 surfaces & 3 borders.

(1) Apex:

- projects upwards through the thoracic inlet extending 1" behind & above the med. third of the clavicle
- it is covered by the cervical pleura & supra pleural memb.
- it is grooved anteriorly by the subclavian a.



(2) Base or diaphragmatic surface:

- is concave & rests on the cupola of the corresponding $\frac{1}{2}$ of the diaphragm
- the base of the Rt. lung is more concave & separated by the diaphragm from the Rt. lobe of the liver
- the base of the Lt. lung is less concave & separated by the diaphragm from the Lt. lobe of liver; fundus of stomach & spleen.

(3) Surfaces : 2 : costal & medial :

A-Costal surface :

is wide, convex & is related to the ribs and the intercostal spaces.

(B) Medial surface :

contains the hilum of the lung.
It is divided into 2 parts :

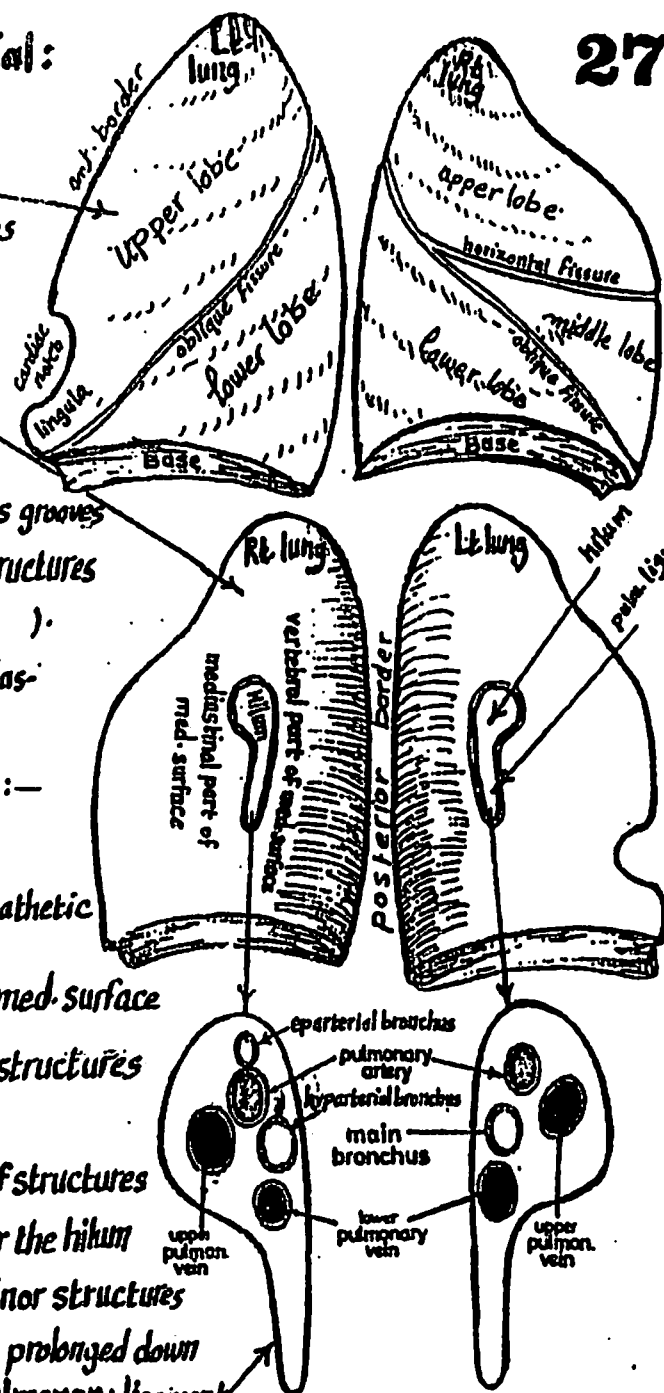
(1) Ant. or mediastinal part : presents grooves and impressions corresponding to the structures in the side of the mediastinum (see page).

The hilum lies in the post part of the mediastinal surface.

(2) post. or vertebral part (behind hilum) : — related to the bodies of the thoracic vertebrae, intercostal n. & vessels & sympathetic chain.

* The Hilum : it is the area on the med. surface of the lung which gives passage to the structures forming the root of the lung

* The Root of the lung : it is the group of structures which pass from the mediastinum to enter the hilum of the lung. They include 3 major & 3 minor structures surrounded by a tubular sheath of pleura prolonged down below the root of the lung to form the pulmonary ligament.



* Structures forming the root of the lung :

Major Structures	Minor structures
<p>(1) <u>Bronchus</u> : occupies a post. position . In the <u>Rt. hilum</u> the main bronchus divides before entering into 2 : eparterial bronchus above the pulmonary a. & hyparterial bronchus below the pulmonary a.</p> <p>(2) <u>Pulmonary a.</u> : in the <u>Lt. hilum</u> it occupies the upper part of the hilum. In the <u>Rt. hilum</u> it lies between the eparterial & hyparterial bronchi</p> <p>(3) <u>2 pulmonary veins</u> : the <u>upper pulmonary v.</u> is the most ant. structure in the hilum. The <u>lower pulm. v.</u> is the most inferior structure in the hilum.</p>	<p>(1) <u>Bronchial vessels</u> : are slender vessels lying on the post. aspect of the bronchus. They supply the bronchial tree & the stroma of the lung. The <u>left lung</u> has 2 bronchial aa. arising from the descending aorta. The <u>Rt. lung</u> has only one artery arising from the 3rd Rt. post. intercostal a.</p> <p>(2) <u>Ant. & post. pulmonary plexuses</u> : lying in front & behind the main structures of the hilum. They are formed of symp. & parasymp. fibres that supply the bronchial tree, lung & visceral pleura.</p> <p>(3) <u>Broncho-pulmonary lymph nodes</u> : lying in between the major structures of the hilum. They drain the lymph of the lung.</p>

* Surface anatomy of the root of the lung: it lies opposite the 5th, 6th & 7th T. vertebrae **28**

- Ant. surface anatomy: represented by a vertical line 1" from the median plane between the 3rd & 5th Costal cartilages.

- Post. surface anatomy: a vertical line 1" from middle line between the 3rd & 5th thoracic spines.

N.B.: the root of the Lt. lung lies 1 cm. below that of the Rt. lung.

(4) Borders of the Lung: 3: ant., post. & inferior:

(A) Anterior border: is thin & sharp border:

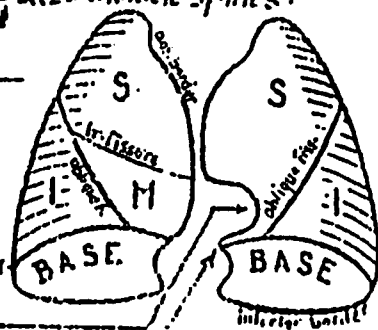
- in the Rt. lung it is straight & corresponds to the ant. border of pleura.

- " " Lt. lung the lower part of the ant. border shows a cardiac notch below which the ant. border sends a thin projection called the lingula.

N.B.: the ant. border of each lung extends into the Costo mediastinal recess of pleura in full inspiration.

(B) Inferior border: is sharp & circular encircling the base (separating it from med. & costal surfaces). It extends into the Costo-diaphragmatic recess of the pleura in full inspiration.

(C) Posterior border: it is thick & rounded border (sometimes referred to as post. surface). it occupies the paravertebral gutter & is related to the heads of ribs, sympathetic chain, post. intercostal vessels & nerve (separated from these structures by the parietal pleura).



* Lobes & Fissures of the lung:

A- the Left Lung: is divided into 2 lobes: upper & lower by the oblique fissure.

- the oblique fissure: resembles the letter 'C' set obliquely so that the convexity cuts the lat. surface of the lung deeply while the opening of the 'C' is fitting with the hilum of the lung.

It begins at the post. border of the lung 2 1/2" below its apex (at the level of the 3rd thoracic spine) & passes anteroinferiorly to end at the inferior border of lung opposite the 6th costochondral junction.

Its surface anatomy: approximately corresponds to the med. border of the scapula when the arm is elevated above the level of the shoulder & put behind the head.

- Lobes of the Lt. lung:

(1) Sup. lobe: above & ant. to the oblique fissure. It includes the apex & the ant. border.

(2) Inf. lobe: below & behind " " " " It includes the base & most of the post. "

(B) the Rt. lung: is divided into 3 lobes upper, middle & lower lobes by 2 fissures:

(1) the oblique fissure: similar to that of the Lt. lung. It separates the upper & middle lobes from inf. lobe.

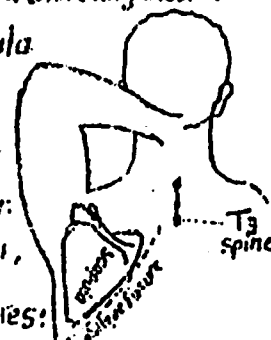
(2) the horizontal " : separates the upper from the middle lobe. It begins at the ant. border opposite the 4th costal cartilage & extends to the right & slightly upwards to join the oblique fissure at the midaxillary line.

- Lobes of the Rt. lung:

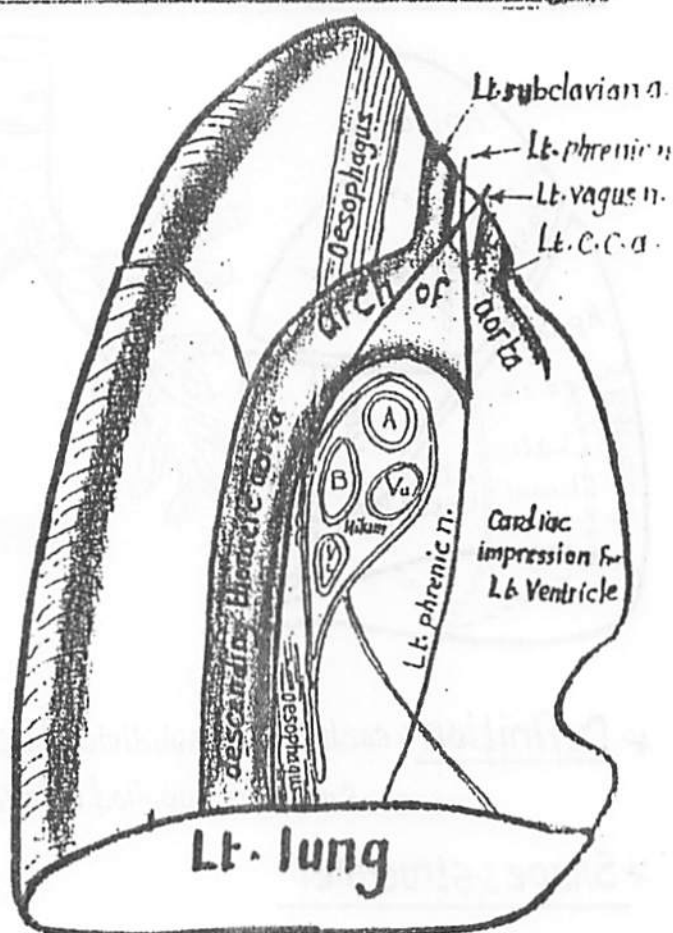
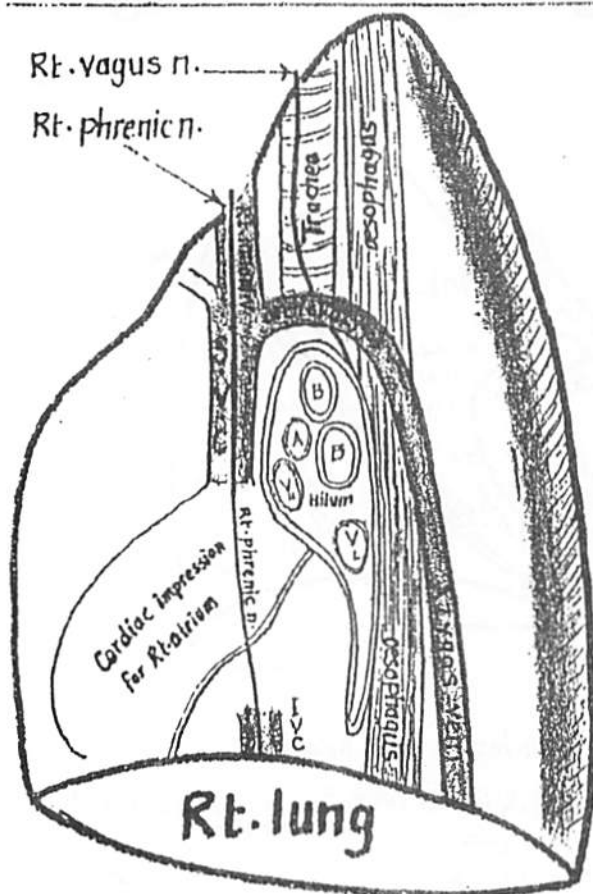
(1) Inf. lobe: identical with that of the Lt. lung.

(2) middle lobe }

(3) upper lobe } are together equivalent to the upper lobe of the Lt. lung.

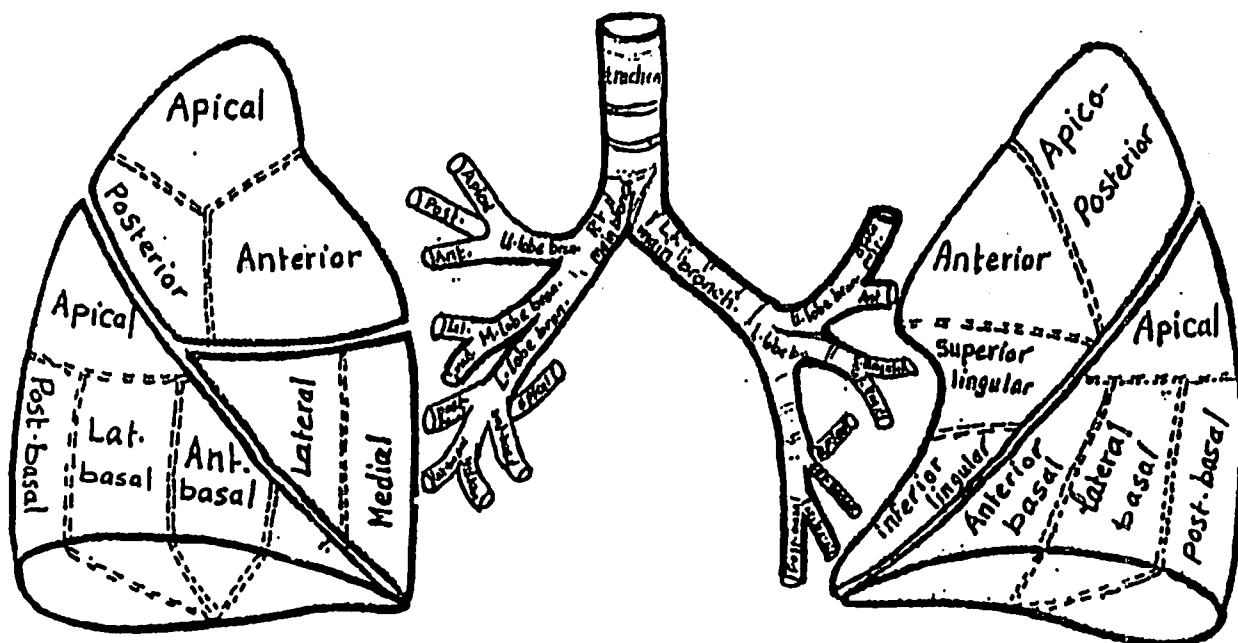


Relations of the Mediastinal Surfaces of lungs



	Mediastinal surface of the Rt. lung	Mediastinal Surface of the Lt. lung
(1) above the hilum	<p>(a) immediately above the hilum there is a curved groove for the <u>arch of azygos v.</u></p> <p>(b) above the level of the arch of azygos there are <u>3 Vertical grooves</u> (from before backwards):</p> <ol style="list-style-type: none"> (1) groove for Rt. innominate v. & phrenic n. (2) groove for the trachea & Rt. vagus n. (3) groove for the oesophagus. 	<p>(a) immediately above the hilum there is a broad arched groove for the <u>arch of aorta</u>.</p> <p>(b) above the level of the arch of aorta there are <u>3 Vertical grooves</u> (from before backwards):</p> <ol style="list-style-type: none"> (1) groove for Lt. C. carotid a. (2) groove for Lt. subclavian a. (3) groove for the oesophagus. <p><i>with Lt. phrenic n. & left vagus n. in between the 2 grooves.</i></p>
(2) in front of the hilum & pulmonary lig.	<p>the mediastinal surface shows:</p> <ol style="list-style-type: none"> (1) a wide concave <u>Cardiac impression</u> related to the Rt. atrium & Rt. phrenic n. (2) a groove for S.V.C & Rt. phrenic n. joining the <u>upper part</u> of the Cardiac impression (in front of the hilum). (3) a groove for I.V.C (& Rt. phrenic n.) joining the <u>lower part</u> of the Cardiac impression (in front of the pulm. ligament). 	<p>the mediastinal surface presents a wide deep concave <u>Cardiac impression</u> related to the left <u>ventricle</u> (& Lt. phrenic n.).</p>
(3) behind the hilum & pulm. lig.	there is a groove for the oesophagus & the azygos v. behind it.	there is a broad longitudinal groove for the descending aorta (and oesophagus in the lower part)

Broncho- Pulmonary Segments 30

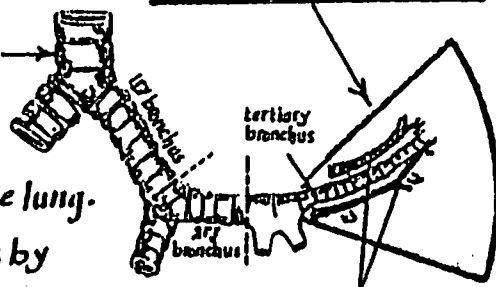


* **Definition:** each lung is subdivided into functionally independent segments each of which is supplied by a tertiary bronchus & called bronchopulmonary segment.

* Shape & structure:

- each broncho-pulmonary segment is wedge shaped having an apex at the hilum of lung & a base at the surface of the lung.
- each segment is separated from the adjacent segments by

Fibrous septa & receives a branch from the pulmonary a. & a radicle of the pulmonary v.



* **Pattern & number of the broncho-pulmonary segments:** differs in both lungs:

Broncho pulmonary segments of Rt. lung (10)	Broncho pulmonary segments of Lt. lung (8)
<p>(A) <u>the upper lobe</u> has 3 segments :</p> <p>(1) apical (2) posterior (3) anterior</p> <p>(B) <u>the middle lobe</u> has 2 segments :</p> <p>(4) lateral (5) medial</p> <p>(C) <u>the lower lobe</u> has 5 segments :</p> <p>(6) apical (7) ant. basal (8) post. basal (9) medial basal (10) lat. basal</p>	<p>(A) <u>the upper lobe</u> has 5 segments :</p> <p>(1) apical (2) posterior (3) anterior } their tertiary bronchi arise from the apico-posterior bronchus (4) Sup. lingular (5) inf. lingular</p> <p>(B) <u>the lower lobe</u> has 5 (or 4) segments :</p> <p>(6) apical (7) ant. basal (8) post. basal (9) lat. basal (10) med. basal (commonly absent or rudimentary)</p> <p><u>N.B:</u> the Lt. lung is considered as consisting of 8 segments because the apical & posterior of the upper lobe have a common bronchus (apico-post. br.) & the medial basal segment of the lower lobe is frequently absent.</p>

Differences between the Rt. & Lt. lungs 31

	Right lung	Left lung
(1) Size	- slightly larger in size - wider - shorter due to the upward bulge of the Rt. cupola of the diaphragm.	- it is slightly smaller in size - narrower because the heart bulges more to the Lt. side
(2) Ant. border	- straight - has no lingula	presents a cardiac notch & projects below the notch forming the lingula.
(3) Fissures	2 : oblique & horizontal	only one fissure : the oblique.
(4) Lobes	3 : upper, middle & lower	only 2 : upper & lower
(5) Hilum	- has 2 bronchi : eparterial & hyparterial - has only one bronchial artery	- has only one main bronchus. - has 2 bronchial arteries
(6) Segments	has 10 broncho-pulmonary segments	has 8 broncho-pulmonary segments

* Arterial supply of lungs:

- the Rt. lung is supplied by one bronchial a. (arising from the 3rd Rt. post. intercostal artery).
 - the Lt. lung is supplied by 2 bronchial aa. arising from the descending thoracic aorta.
- N.B : the bronchial aa. supply oxygenated blood to the lung stroma & the bronchial tree.

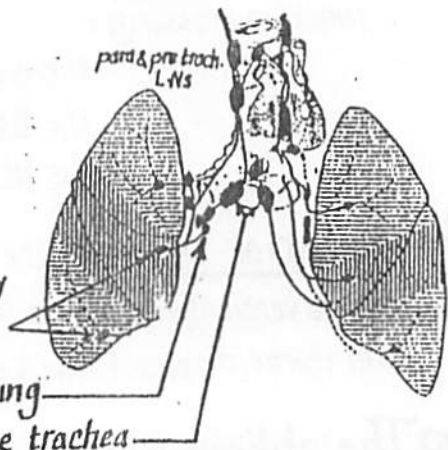


* Venous drainage of lungs: 2 bronchial vv. drain each lung:

- the Rt. bronchial veins : open into the azygos v.
- the Lt. " " " " " " " " : open into the sup. hemiazygos v.

* Lymphatic drainage of lungs:

the interstitial lymphatics of the lung drain from the periphery towards the hilum passing through intrapulmonary lymph follicles to reach the broncho pulmonary L.Ns. at the hilum of the lung then to the tracheo-bronchial L.Ns. at the bifurcation of the trachea then they reach the pre & paratracheal L.Ns which are drained by the mediastinal lymph trunk.



* Nerve supply of lungs: is derived from the ant. & post. pulmonary plexus

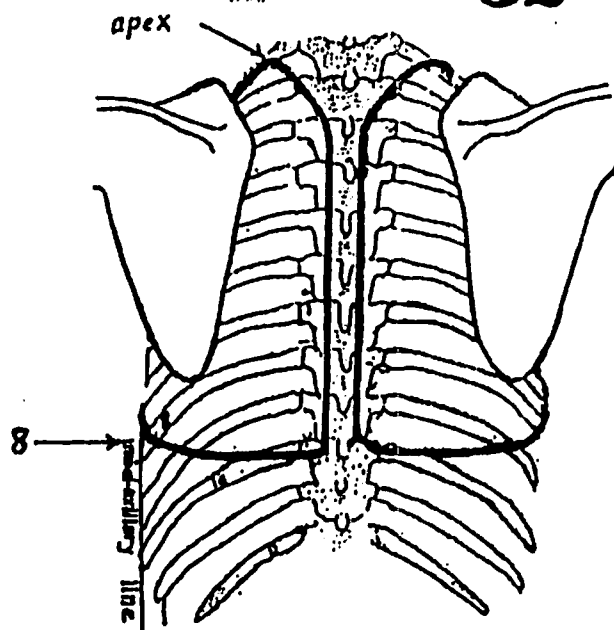
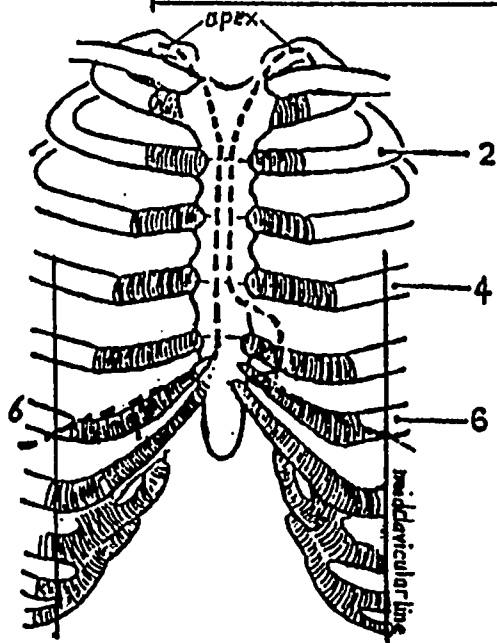
found at the roots of the lungs & formed of :

- (1) Sympathetic fibres (vaso constrictor & bronodilator): from the 2nd, 3rd & 4th ganglia of the thoracic sympathetic chain.
- (2) parasymp. fibres (vaso dilator & broncho constrictor) from the vagus n.

N.B : afferent impulses from the lung reach the C.N.s in both the symp. & parasymp. fibres



Surface anatomy of the lung 32



(1) **Apex of the lung** : the same as surface anatomy of the Cervical pleura .

(2) **the ant. border** :

- **of the Rt. lung** : Corresponds to the ant. border of the Rt. pleura (see page 25) .

- **of the Lt. lung** : Corresponds to the ant. border of the Rt. pleura as far down as the level of the 4th costal Cartilage then the ant. border of the Lt. lung separates from that of the left pleura & deviates $\frac{1}{2}$ an inch lat. to the lateral border of the sternum (forming the cardiac notch of the lung) then it curves downwards & medially to end at the 6th costochondral junction.

(3) **Lower border** : (the same for the Rt. & the Lt. lungs) :

it is represented by a curved line around the chest wall starting at the 6th sterno-costal junction crossing :

the 6th rib in the midclavicular line .

the 8th " " " midaxillary line .

the 10th thoracic spine posteriorly where the lower border ends .

(4) **Posterior border** (the same for the Rt. & Lt. lungs) :

it runs vertically upwards alongside the vertebral column starting from the level of the 10th thoracic spine below & ending at the point of the apex above .

(5) **The oblique fissure** : draw a line passing obliquely downwards & outwards starting from a point 3 cm. lat. to the spine of the 3rd thoracic spine to the 6th costal Cartilage 3 fingers from the median plane . (Another method of surface anatomy : see page 28) .

(6) **The Horizontal fissure (of the Rt. lung)** :

draw a line starting from the ant. border of the Rt. lung at the 4th costal Cartilage & running to the Rt. & slightly upwards to meet the oblique fissure in the midaxillary line .

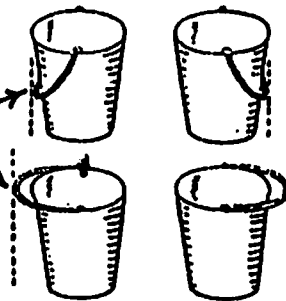
* **CLINICALLY IMPORTANT POINTS RELATED TO LUNG** : see page 98 .

Movements of respiration

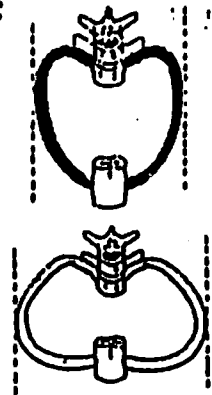
33

(A) Inspiration: entails the increase in the 3 diameters of the thorax:

(1) Transverse diameter: is increased when the lower costal arches (the ribs & their costal cartilages) swing up & out (like the handle of the bucket) by the action of the intercostal muscles.



Bucket handle action



Lateral expansion

(2) Antero-posterior diameter:

is increased when the sternum is pushed forwards & upwards, this occurs when the ant. ends of the upper (vertebro-sternal) ribs (from 2-7) are raised. The manubrio-sternal joint allows forward movement of the body of the sternum (by a hinge-like movement) while the manubrium is fixed.



Anteroposterior expansion

(3) the Vertical diameter:

is increased by the contraction of the diaphragm leading to descent of its cupolae.



Descent of diaphragm

* Types of inspiratory efforts:

(1) quite inspiration: entails the contraction of the diaphragm & intercostal muscles.

(2) deep inspiration: involves the contraction of the accessory muscles of inspiration:

(a) the scalene muscles of the neck: elevate the 1st & 2nd ribs. } increase the capacity of upper part of thoracic cavity.
(b) the sternomastoid m.m.: raise the manubrium sterni.

(3) Deeper or forced inspiration: involves the contraction of pectoralis major & minor muscles & serratus ant. m. which causes more raise of the upper ribs.

(B) Expiration:

(1) quite expiration: is a passive process caused by:

- (a) the elastic recoil of the expanding lung.
- (b) the elastic recoil of the twisted costal cartilages depresses the ribs & retracts the sternum.
- (c) the intraabdominal pressure elevates the diaphragm upwards.

(2) forced expiration: is an active process involving:

- (a) Contraction of the abdominal muscle → more increase of intra abdominal pressure → more elevation of the diaphragm.
- (b) Contraction of latissimus dorsi m. Compressing the lower ribs.

Mediastinum

34

*Definition:

- it is a thick mass of tissues occupying the median part of the thoracic cavity forming a median septum between the 2 pleural cavities, extending from the sternum anteriorly to the vertebral column posteriorly.

*Structure :

- (a) the heart & the large vessels of the thorax.
- (b) the tubes entering the thorax (trachea & oesophagus).
- (c) the nerves, lymph nodes & lymph vessels of thorax.

*Boundaries:

- Anteriorly : Sternum
- posteriorly : vertebral column.
- superiorly : the plane of thoracic inlet.
- inferiorly : the diaphragm.
- on each side : the lung & mediastinal pleura.

*DIVISIONS :

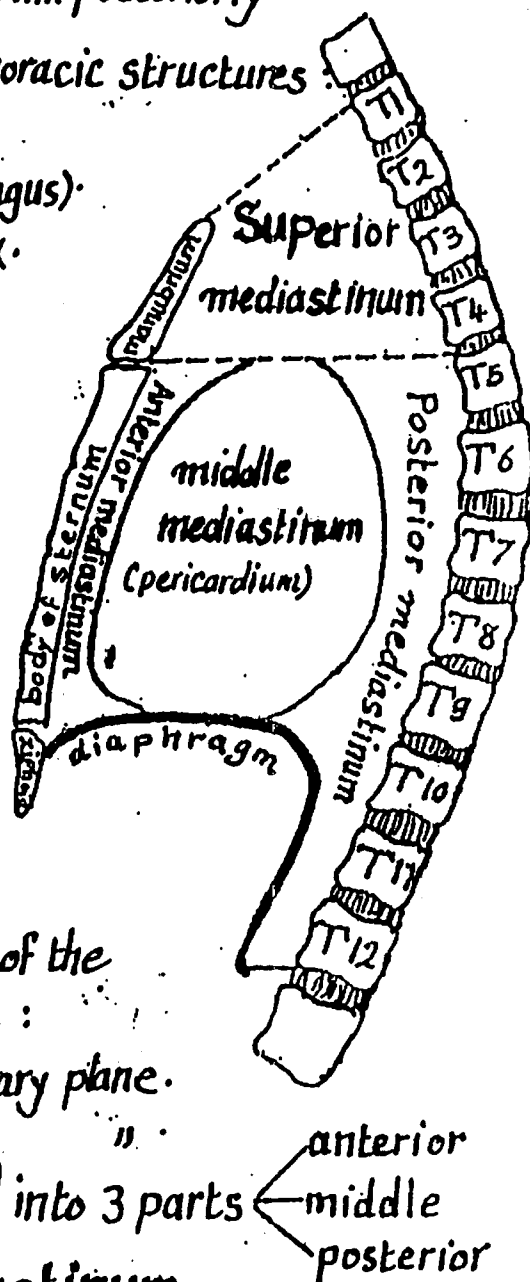
- for descriptive purposes, the mediastinum is divided by an imaginary plane extending from the sternal angle (anteriorly) to the lower border of the body of T₄ vertebra (posteriorly) into 2 parts :
(A) Superior mediastinum : above the imaginary plane.
(B) inferior : below " " " "

- The inf. mediastinum is further subdivided into 3 parts

*The 4 subdivisions of the mediastinum

I- Superior mediastinum

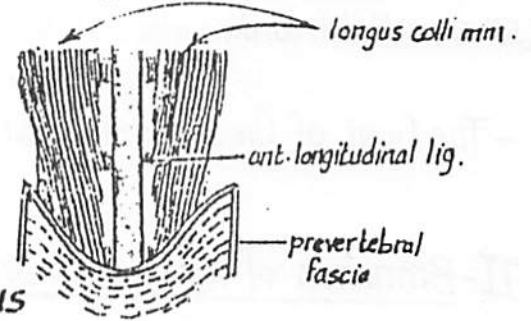
- Boundaries : (a) anteriorly : manubrium sterni
(b) posteriorly : the upper 4 thoracic vertebrae.
(c) superiorly : the plane of the thoracic inlet (p. 11)
(d) inferiorly : an imaginary plane passing through the sternal angle (in front) & the lower border of T₄ vert. (behind).
(e) on each side : mediastinal pleura.



* The contents of the sup. mediastinum can be arranged in 5 layers (from behind forwards) as follows :

(A) Prevertebral layer : contains :

- (1) the ant. longitudinal ligament.
- (2) the 2 longus colli muscles.
- (3) the prevertebral fascia which covers the previous structures & blends with the ant. longitudinal lig. at the lower border of T₄.



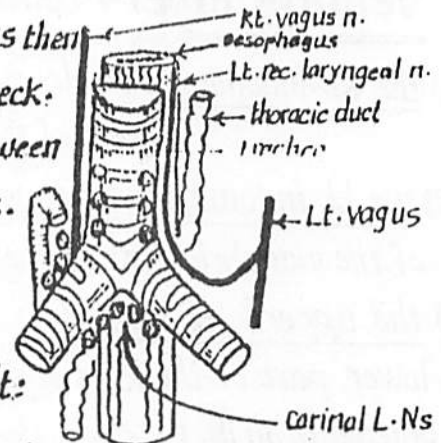
(B) Tubal layer : contains the oesophagus & trachea (and related structures):

(1) the oesophagus : descends in front of the vertebral column with 2 structures :

- (a) thoracic duct : ascends on the Lt. side of the oesophagus then passes through the thoracic inlet to reach the root of the neck.
- (b) Lt. recurrent laryngeal n. : ascends in the Lt. groove between the trachea & the oesophagus.

(2) the Trachea : descends in front of the oesophagus & ends at the lower border of T₄ by dividing into 2 bronchi. It has the following structures related to it:

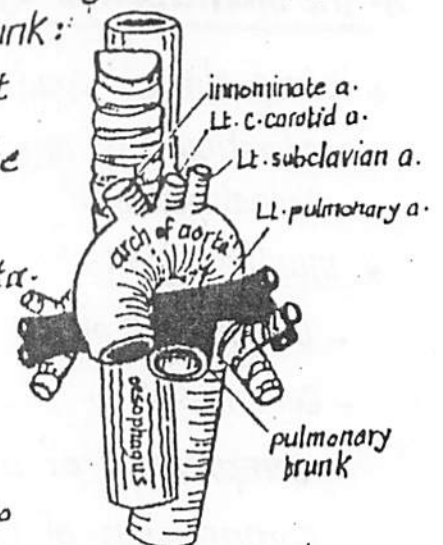
- (a) Lymph nodes :
 - Rt. & Lt. paratracheal L.Ns : on each side of the trachea
 - Rt. & Lt. tracheobronchial n. : at the 2 angles between trachea & bronchi
 - Carinal L.Ns : on & below the tracheal bifurcation (the Carina).
- (b) Rt. vagus n. : descends along the Rt. side of the trachea.
- (c) the deep cardiac plexus : lying in front of the tracheal bifurcation.
- (d) the arch of azygos v. : on the Rt. side of the Rt. tracheobronchial angle.



(C) Arterial layer : includes the aortic arch & its branches together with the termination of the pulmonary trunk :

I- the arch of aorta : ascends upwards & to the Lt. in front of the trachea then turns backwards on the Lt. side of the trachea & oesophagus to reach the Lt. side of the body of T₄ where it continues as the descending thoracic aorta. - the concavity of the arch is occupied by :

- (1) the bifurcation of the pulmonary trunk.
- (2) the Lt. bronchus.
- (3) ligamentum arteriosum : (Connecting the Lt. pulmonary a. to the arch of aorta).



(4) Lt. recurrent laryngeal n. : a branch of the Lt. vagus n. which hooks below the ligamentum arteriosum then ascends deep to the arch of aorta. 36

(5) superficial cardiac plexus : lies on the ligamentum arteriosum, below the arch of aorta.

- The front of the arch of aorta is related to :
→ Lt. phrenic & Lt. vagus nerves
→ Lt. sup. intercostal v.
→ Cardiac branches of Lt. vagus & Lt. symp. trunk.

II- Branches of the aortic arch :
(1) innominate a.
(2) Lt. Common carotid a.
(3) Lt. subclavian a. } arranged from Rt. to Lt. & also from before backwards.

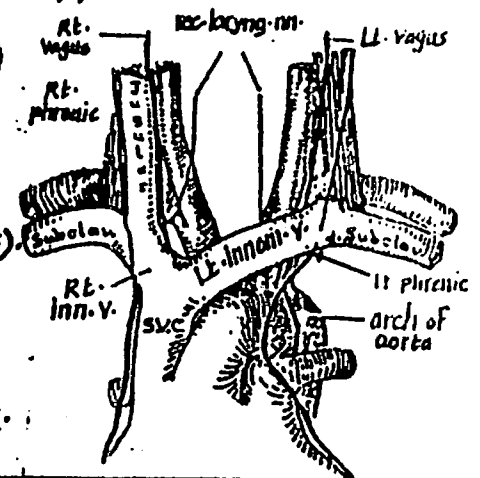
III- the termination of the pulmonary trunk : lies within the concavity of the aortic arch.

D- Venous layer : contains the 2 innominate veins & the upper $\frac{1}{2}$ of the S.V.C. :

(1) the Rt. innominate v. : descends vertically behind the upper part of the Rt. margin of the manubrium.

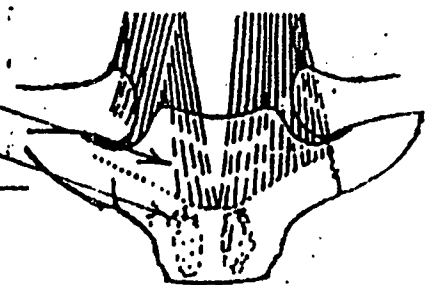
(2) the Lt. innominate v. : runs obliquely behind the upper $\frac{1}{2}$ of the manubrium above the aortic arch (crossing its 3 branches).

(3) the upper $\frac{1}{2}$ of the S.V.C. : descends vertically behind the lower part of the Rt. margin of the manubrium with the Rt. phrenic n. on its Rt. side & the arch of azygos v. joining its back.



E- Retrosternal layer : contains :

- (1) the origins of sternohyoid & sternothyroid muscles
- (2) remains of the thymus gland.



Clinical importance

* The mediastinal Syndrome :

* It is a clinical condition caused by compression of the contents of the superior mediastinum by any space occupying lesion (e.g : tumor, enlarged L.Ns or retro-sternal goitre).

* manifestations :

- Compression of the veins → venous congestion in the U.L. & head & neck.
- Compression » » arteries → ischaemia of the U.L. & head & neck.
- Compression of the trachea → dyspnea.
- Compression of the oesophagus → dysphagia.

II- Anterior mediastinum

37

* it is a narrow space in front of the pericardium, overlapped by ant. borders of both lungs.

- * Boundaries : - anteriorly : body of the sternum.
- posteriorly : the pericardium.
- superiorly : the imaginary plane separating the sup. mediastinum from the inf. mediastinum.
- inferiorly : sup. surface of the diaphragm.
- on each side : mediastinal pleura.

- * Contents : (1) remains of the thymus gland & loose areolar tissue.
(2) upper & lower sternopericardial ligaments connecting the pericardium to the back of the sternum.
(3) 2-3 lymph nodes & lymph vessels.
(4) small mediastinal brs. of internal thoracic arteries.

III- Middle mediastinum

* It is the broadest part of mediastinum & is occupied by the pericardium & its content

* Contents :

- (1) the heart enclosed in the pericardium.
- (2) Arteries : (a) ascending aorta (b) pulmonary trunk & the 2 pulmonary arteries.
- (3) Veins : (a) lower $\frac{1}{2}$ of the S.V.C (b) terminal part of the azygos vein.
(c) upper part " " I.V.C (d) the Rt. & Lt. pulmonary veins.
- (4) Nerves : (a) both phrenic nerves (b) the deep cardiac plexus.
- (5) Tubes : (a) the bifurcation of trachea (b) the Rt. & Lt. principal bronchi.
- (6) Lymph Ns : Tracheobronchial L.Ns.

IV- Posterior Mediastinum

- * Boundaries : - anteriorly : (a) pericardium (b) post. part of upper surface of diaphragm.
- posteriorly : the lower 8 thoracic vertebrae.
- on each side : Mediastinal pleura.

* Contents

- (1) Tubes : the Oesophagus.
- (2) Arteries : descending thoracic aorta & its branches.
- (3) Veins : Azygos & hemiazygos veins.
- (4) Nerves : (a) Vagi (forming oesophageal plexuses around the oesophagus).
(b) both sympathetic chains & their splanchnic nerves.

The Pericardium

38

* **Definition** : it is a fibroserous sac surrounding the heart & the roots of the great vessels arising from or entering it.

* **Site** : it is situated in the middle mediastinum.

* **Structure** : it consists of 2 sacs :

- (a) an outer fibrous sac called Fibrous pericardium.
- (b) an inner double-layered sac » Serous pericardium.

(A) Fibrous Pericardium

* **Shape** : Conical sac made up of strong fibrous tissue. It has apex, base, ant. surface, post. surface & 2 lat. surfaces (Rt. & Lt.).

* **Attachments** :

- the base (below) : is attached to the central tendon of the diaphragm.
- the apex (above) : extends upwards to the level of the sternal angle. Where it blends with the adventitia of the big vessels (ascending aorta, pulmonary trunk & S.V.C) and with the pretracheal fascia.

* **Relations** :

(1) Anterior surface :

- it is related to the sternum & costal cartilages but separated from them by ant. borders of both lungs & pleurae.
- it is connected to the back of the sternum by the sup. & inf. sternopericardial ligaments.

(2) Rt. & Lt. Lateral Surfaces :

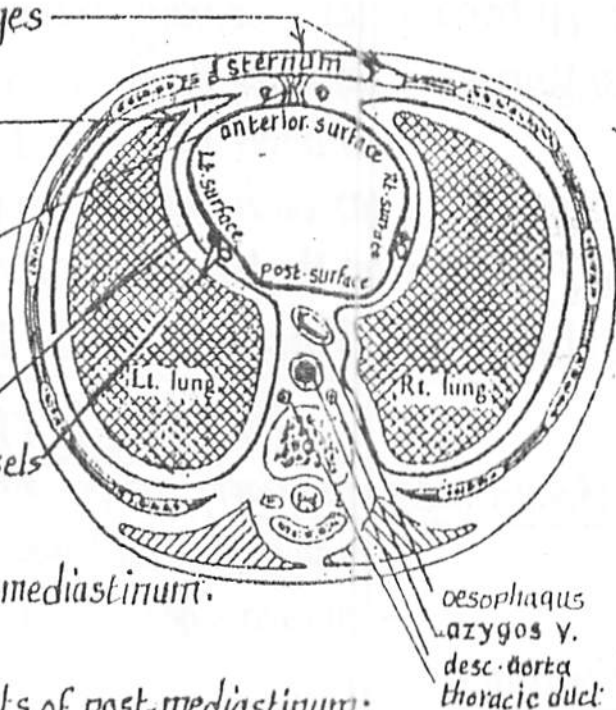
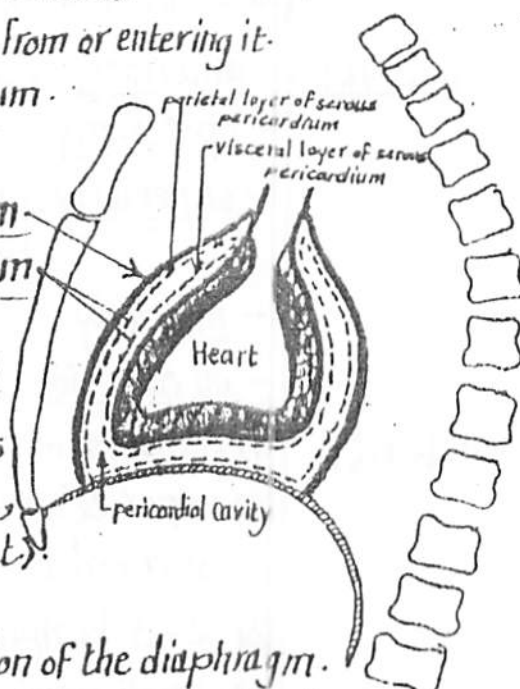
- each lat. surface is related to:
 - (a) mediastinal surface of lung & pleura
 - (b) phrenic n. & pericardiophrenic vessels

(3) Posterior surface :

- it forms the ant. boundary of the post. mediastinum.
- it is pierced by 4 pulmonary veins.
- it is related to the principal bronchi & contents of post. mediastinum:
 - (a) oesophagus (b) descending aorta (c) azygos vein (d) thoracic duct.

* **Functions of Fibrous pericardium** :

- (1) maintains a constant position for the heart.
- (2) being non-elastic, it prevents overdistension of the heart.
- (3) keeps the mouths of the blood vessels open, not affected by cardiac or respiratory movements.



(B)- Serous Pericardium

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* Definition: it is a closed serous sac which is invaginated from above & behind, by the heart & the roots of its big vessels

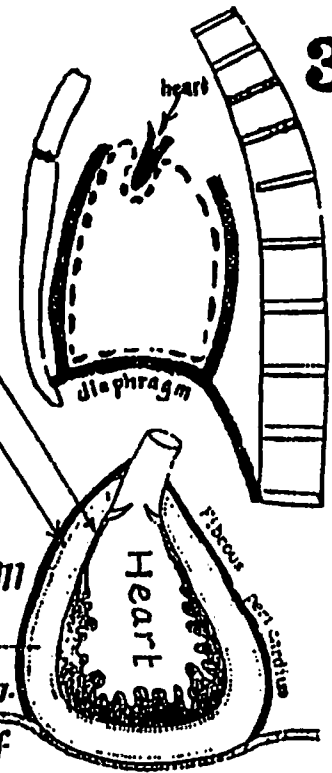
* Structure: this invagination converts the serous sac into potential space having 2 layers (a) visceral (b) parietal

(a) parietal layer: lines the fibrous pericardium & is reflected to the roots of the large vessels to become continuous with the visceral layer.

(b) Visceral layer: Covers the heart & is called the epicardium

(c) the Pericardial Cavity: is a potential space between the visceral & parietal layers of the serous pericardium.

It contains a thin film of serous fluid secreted by the cells of serous pericardium.



* Functions of the Serous pericardium:

(1) lubrication of the heart preventing friction during its movements.

(2) prevents adhesions between the heart & the surrounding organs.

* Blood Supply of the pericardium: the fibrous & parietal serous pericardium are supplied by branches from:

(a) internal thoracic arteries (b) musculophrenic arteries (c) pericardiophrenic aa. (d) descending thoracic aorta.

* Nerve supply of the pericardium:

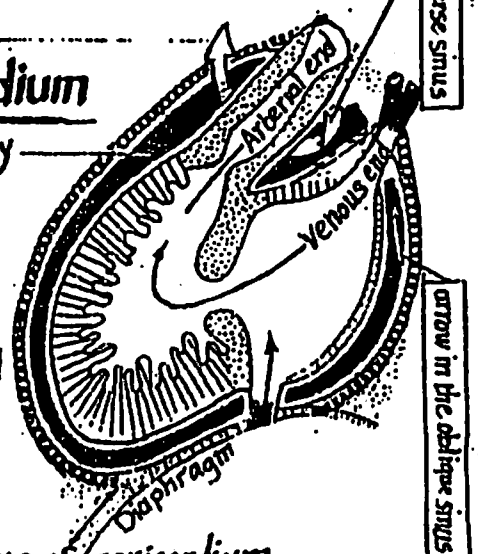
(a) Fibrous pericardium + parietal serous pericardium are supplied by the phrenic n. They are sensitive to pain (as the pain of pericarditis).

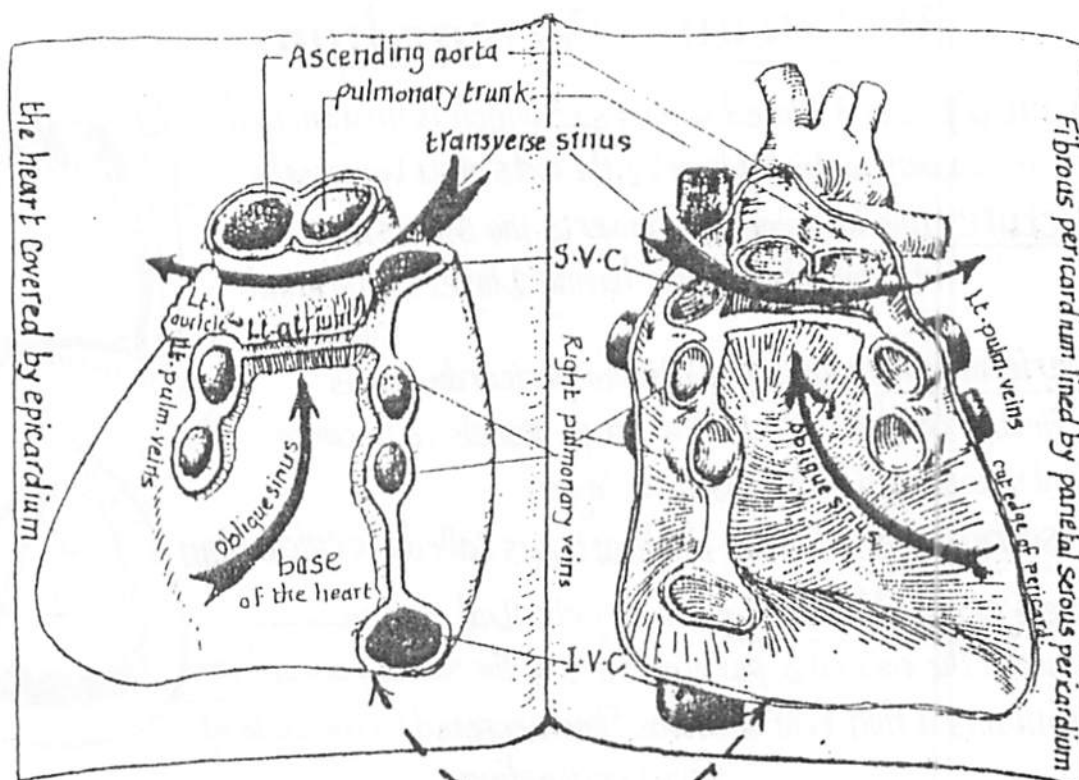
(b) Visceral layer of serous pericardium, like the heart, is supplied by autonomic nerves (sympathetic & parasympathetic). It is insensitive to pain but sensitive to ischaemia.

Sinuses of the Serous pericardium

* Definition: they are recesses inside the pericardial cavity (lined by serous pericardium). They include the transverse sinus & the oblique sinus.

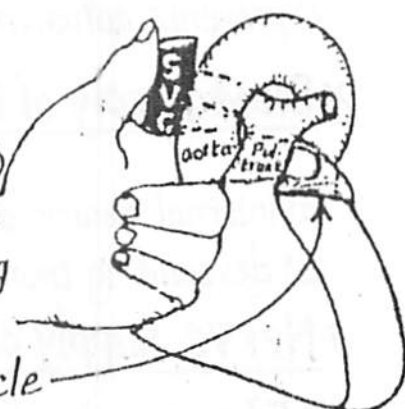
* Introduction: the epicardium at the roots of the great vessels is arranged to form 2 tubes (a) ant. tube surrounding the arterial end of the heart (aorta & pulm. trunk) (b) post. tube enclosing the venous end of the heart (venae cavae & pulm. veins). The passage between the 2 tubes is known as the Transverse sinus while the recess behind the venous end is known as the Oblique sinus of pericardium.





(A) Transverse sinus of pericardium:

- it is a transverse passage between the arterial & venous ends of the heart tube & connecting the Rt. & Lt. parts of the pericardial cavity
- Boundaries:
 - in front: ascending aorta & pulmonary trunk.
 - behind & above: the Rt. pulmonary artery.
 - behind & below: the S.V.C & 2 atria (especially the Lt.)
- to demonstrate the transverse sinus: put a finger in front of the lower part of the S.V.C & push it to the left behind the ascending aorta & pulmonary trunk. The finger traverses the sinus & appears at its left end between the pulmonary trunk & the Lt. auricle.



(B) Oblique Sinus of the pericardium:

- it is a blind recess of the pericardial cavity that lies behind the base of the heart.
- Boundaries:
 - (a) anteriorly: the post. wall of Lt. atrium (base of the heart).
 - (b) posteriorly: the fibrous pericardium (lined by parietal layer of serous pericardium).
 - (c) above: it is closed by the reflection of serous pericardium on the back of Lt. atrium.
 - (d) on the Rt. side: reflection of serous pericardium on to the 2 Rt. pulmonary veins & the 2 Venae Cavae.
 - (e) on the Lt. side: reflection of the serous pericardium on to the 2 Lt. Pulmonary veins.
- Below, the sinus is open to the general pericardial cavity & its entrance is bounded by the I.V.C (below & to the Rt.) & the lower Lt. pulmonary V. (above & to the Lt.).
- Significance of the oblique sinus: it acts as a bursa behind Lt. atrium permitting its pulsations.

CLINICALLY IMPORTANT POINTS RELATED TO PERICARDIUM : see page 98.

Fixation of the pericardium & heart in position 41

"Cardiac Sling Mechanism"

The heart is kept in position inside the thorax by the following mechanisms

A-Fixation of the pericardium to the adjacent structures:

- (1) to the sternum by the sternopericardial ligaments.
- (2) to the base of the skull by the carotid sheath.
- (3) to the deep fascia of neck by the pretracheal fascia.
- (4) to the diaphragm below.

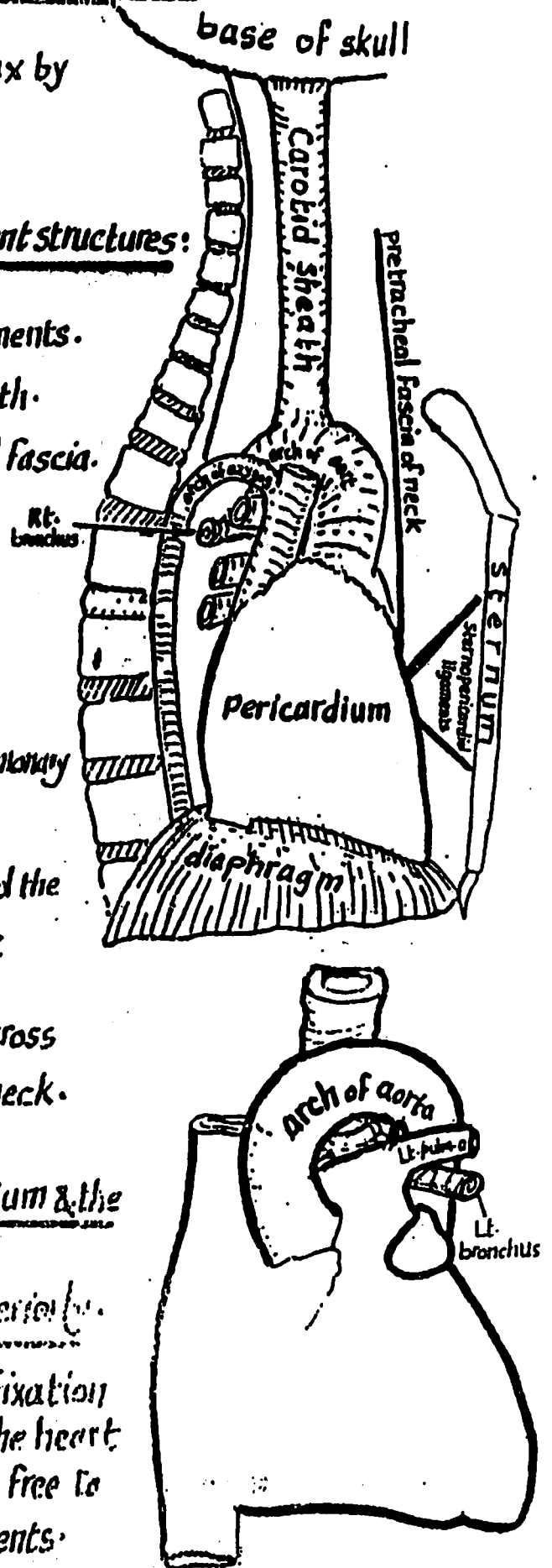
(B) Hooking of the great vessels of the heart around thoracic structures:

- (1) the hooking of the arch of aorta & the Lt. pulmonary a. around the Lt. bronchus
- (2) the hooking of the arch of azygos v. around the Rt. bronchus before opening into the S.V.C
- (3) the arching of the subclavian vessels across the first rib of each side at the root of neck.

(C) the pleurae & lungs support the pericardium & the heart from the sides

(D) the diaphragm supports the heart inferiorly.

N.B: the cardiac sling mechanism induces its fixation effect in the upper post. part (base of the heart) leaving the lower ant. (ventricular) part free to contract accompanying inspiratory movements.



Heart

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* It is a muscular pump which maintains the circulation of blood.

* **Position**: it lies obliquely in the middle mediastinum inside the pericardium so that:

(a) $\frac{1}{3}$ of it lies to the Rt. & $\frac{2}{3}$ to the Lt. of the median plane.

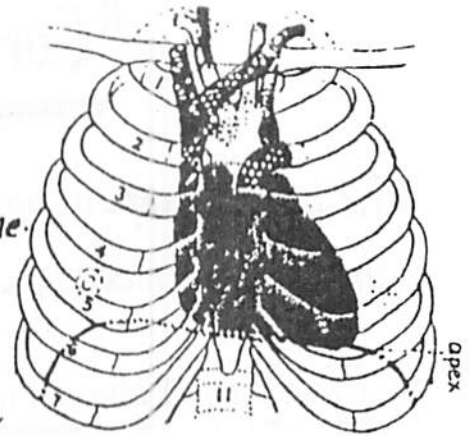
(b) its long axis (the line from the base to the apex) is directed downward, forwards & to the left.

(c) its base (post. surface): lies opposite:

- the middle 4 Th. vertebrae (T5-T8) in the recumbent position.

- the vertebrae T6-T9 in the erect position.

(d) its apex: lies opposite the Lt. 5th intercostal space $3\frac{1}{2}$ from the middle line.



* **Size**: the size of the heart of a person is slightly larger than his closed fist.

- Its long axis is 12 cm.

- its weight is about 300 gm in the male & 250 gm in the female.

* **Shape**: Cone-shaped having:

(a) **base** or post. surface: directed backwards & to the right.

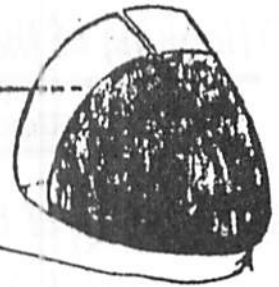
(b) **apex**: is the lowermost & leftmost point of the heart. It is directed downwards, forwards & to the left.

(c) **2 surfaces**:

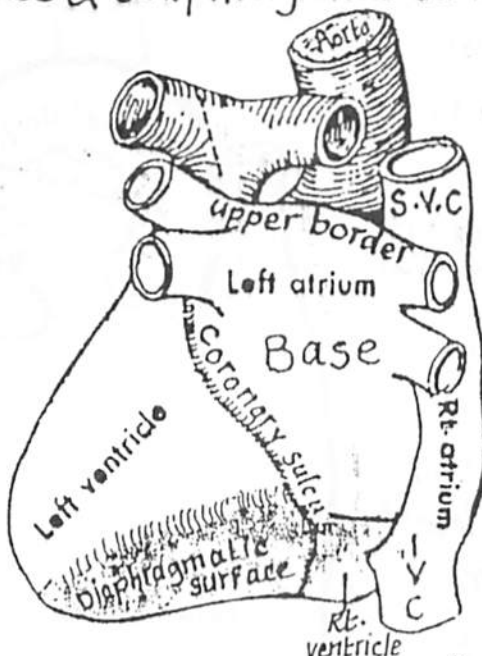
(1) sternocostal surface (ant. aspect).

(2) inferior or diaphragmatic surface.

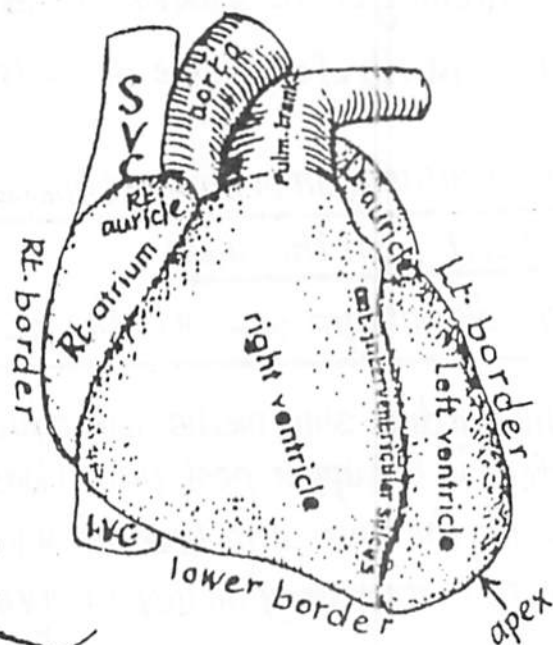
(d) **4 borders**: Right, left, superior & inferior.



Base & diaphragmatic surface



Sterno costal surface



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* Put the following 4 points on the ant chest wall:

point (a) : on the lower border of the 2nd Lt. costal cartilage 4 cm from the middle line.

point (b): on the upper border of the 3rd Rt. costal cartilage 3 cm from the middle line.

Point (c): on the Rt. 6th costal cartilage 3 cm from the middle line.

point (d) : on the Lt. 5th intercostal space 9 cm from middle line (apex of the heart).

(1) the upper border : is a straight line between the points a & b.

(2) the lower border: a straight line between the points c & d.

(3) the right border: a line slightly curved laterally between the points b & c.

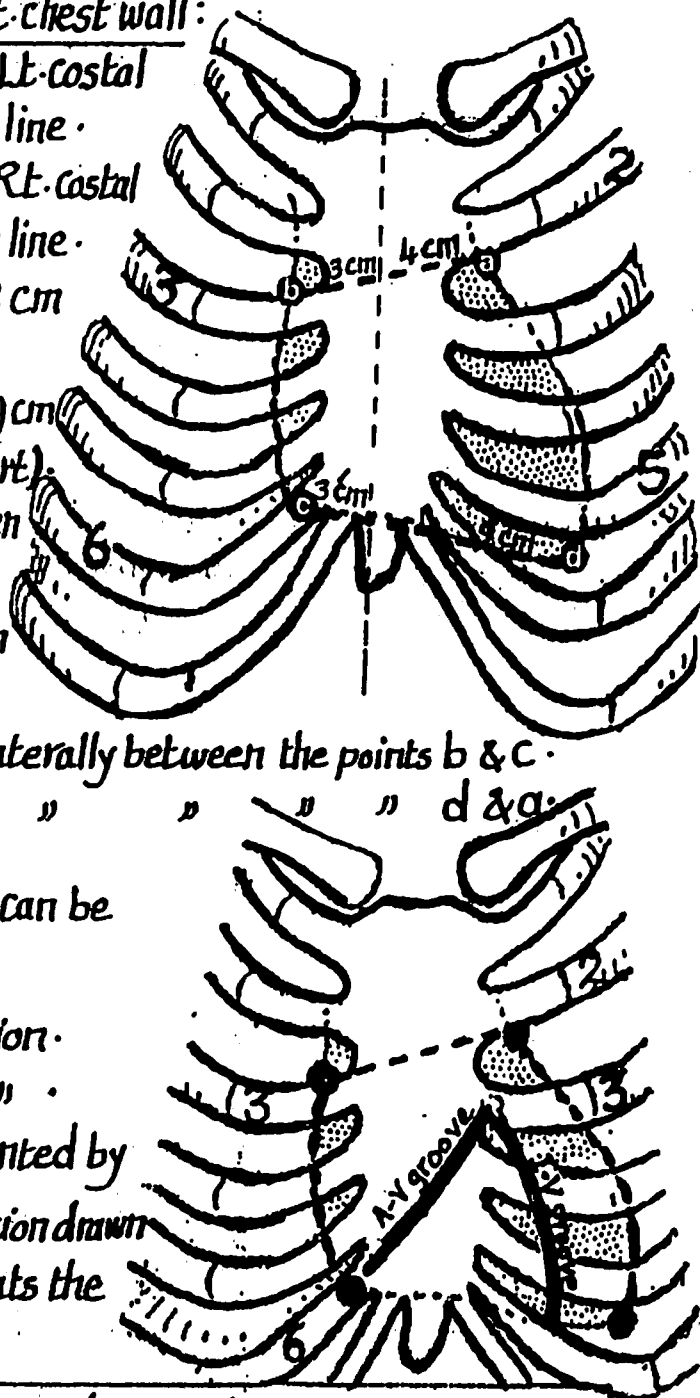
(4) the left border: a " " " " " " " d & g;

(5) Atrioventricular groove : its ant. part can be represented by a line between 2 point :

(a) point on the 3rd L. sternocostal junction.

(b) " " " 6th Rt " " " "

(6) Interventricular groove: represented by a line from the 3rd Lt. sternocostal junction drawn parallel to left border of the heart till it meets the inferior border.



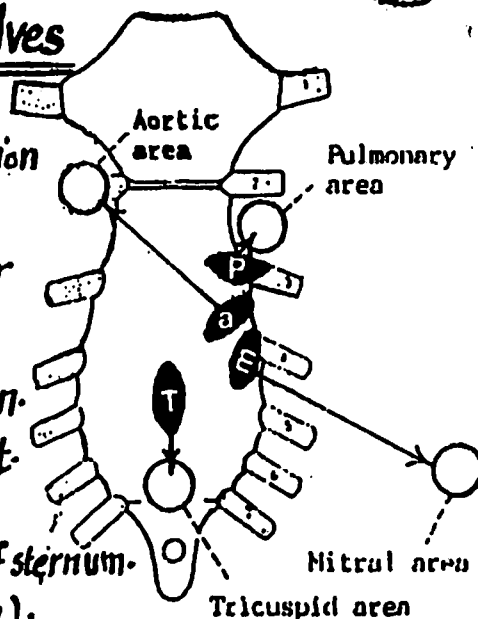
* Surface anatomy of Cardiac Valves

(1) Pulmonary (P) valve: at 3rd Lt. sternal junction
(heard at the 2nd Lt. space).

(2) Aortic (A) valve: 3rd space at the Lt.-sternal border
(heard at the 2nd Rt. space).

(3) Mitral (M) valve : at 4th Lt. sternocostal junction.
(heard at the apex of the heart i.e 5th Lt.
space 9 cm from middle line)

(4) Tricuspid (T) valve: in the 4th space behind the centre of sternum. (heard at the xiphisternal junction).



External Features of the heart

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(1) The Base (posterior surface):

- * Shape : rather flat & quadrilateral in outline.
- * Chambers : it is formed mainly by the Lt. atrium & to a small extent by the Rt. atrium.
- * Direction : backwards & to the right.
- * grooves : it is limited below by post. part of coronary sulcus
- * relations :

(a) posteriorly : it is related to the middle 4 thoracic vertebrae but separated from it by :

- (1) oblique sinus of the pericardium
- (2) structures of the post. mediastinum
 - oesophagus
 - azygos vein
 - descending thoracic aorta
 - thoracic duct.

(b) superiorly : the Rt. & Lt. pulmonary arteries run along upper border of the base

(c) Inferiorly : it is separated from the diaphragmatic surface by the post. part of coronary sulcus lodging :

- a] the Rt. coronary a.
- b] the circumflex br. of Lt. coronary a.
- c] the Coronary sinus.

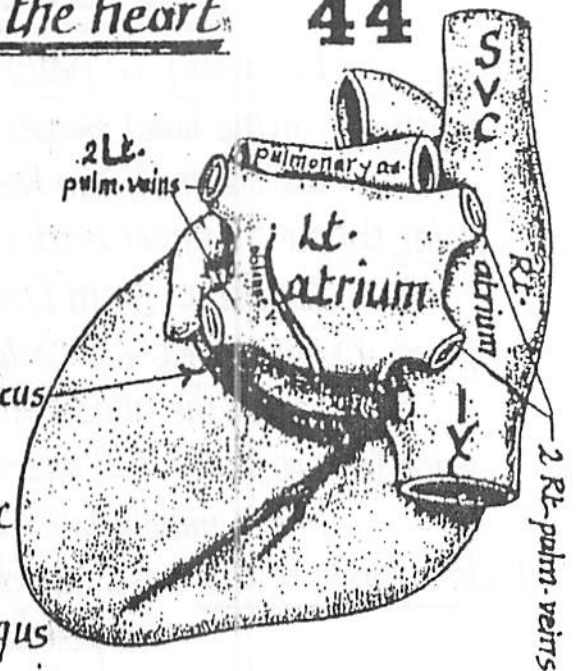
(d) The Rt. border : (a) The sup. vena cava enters the base at the Rt. upper angle

(b) The inf. vena cava " " " " " Rt. lower angle

(c) The 2 Rt. pulmonary vv. pierce the base between S.V.C & I.V.C (but a little to the left side of them).

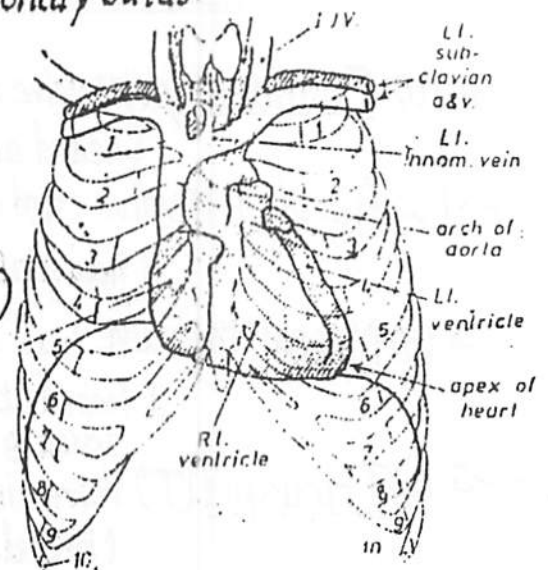
(e) The Lt. border : The 2 Lt. pulmonary vv. pierce the base near its Lt. border

(f) Vessels running on the base : a small v. called Oblique v. of Lt. atrium descends on the base of heart to open into the coronary sinus.



(2) The Apex :

- * formed by the Lt. ventricle.
- * directed downwards, forwards & to the Lt.
(It is the left most & lowermost point of the heart)
- * lies opposite the 5th left intercostal space ,
3 1/2 " (9 cm) from the median plane
- * Related to the Lt. pleura & lung.



(3) The Inferior (diaphragmatic) Surface:

* Shape : Slightly concave & triangular in outline

* Direction : downwards & slightly backwards

* Chambers forming it :

a) Lt. ventricle forms its Lt. $\frac{2}{3}$

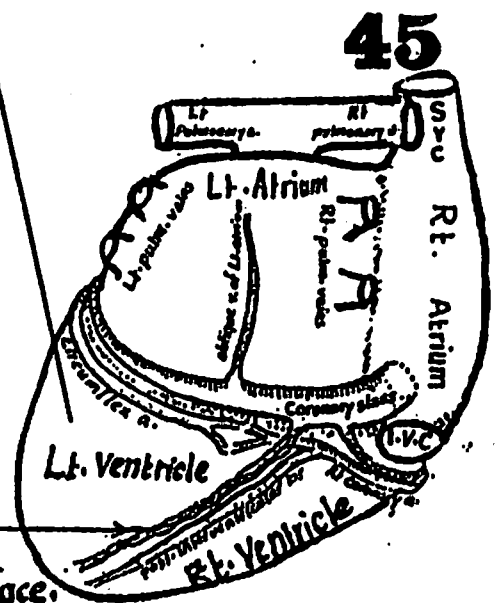
b) Rt. ventricle forms its Rt. $\frac{1}{3}$

* Grooves running on it :

The inferior (post.) interventricular sulcus runs along the line separating the 2 ventricles on inf. surface.

* Vessels related to it : a) the inf. (post.) interventricular br. of Rt. coronary a. +
b) the middle cardiac vein : runs along the posterior interventricular sulcus

* Relations : the inf. surface rests on the diaphragm (mainly the central tendon & to a lesser extent the fleshy part) which separates inf. surface from : a) Lt. lobe of liver b) fundus of stomach



(4) The Sternocostal surface:

* Shape : Convex.

* Direction : forwards, Upwards & to the Lt.

* Chambers forming it :

It is divided by the coronary sulcus into:

a) Atrial portion : above & to the Rt. of coronary sulcus. It is formed almost completely by Rt. atrium & its auricle.

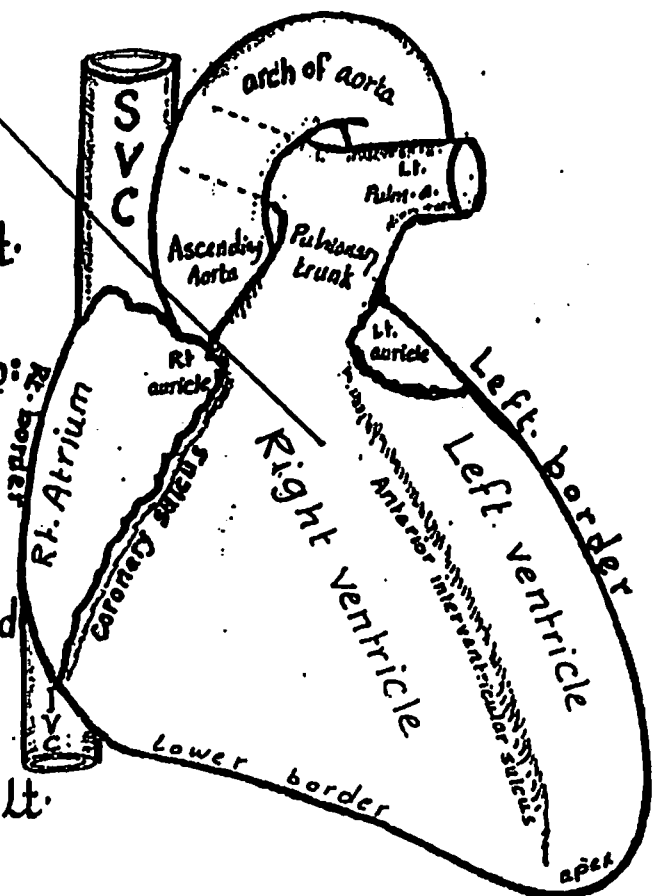
The part formed by Lt. atrium is masked by the ascending aorta & pulmonary trunk.

b) Ventricular portion : below & to the Lt. of coronary sulcus.

It is divided by the anterior interventricular sulcus into :

- Rt. $\frac{2}{3}$ formed by the Rt. ventricle.

- Lt. $\frac{1}{3}$ formed by the Lt. ventricle.

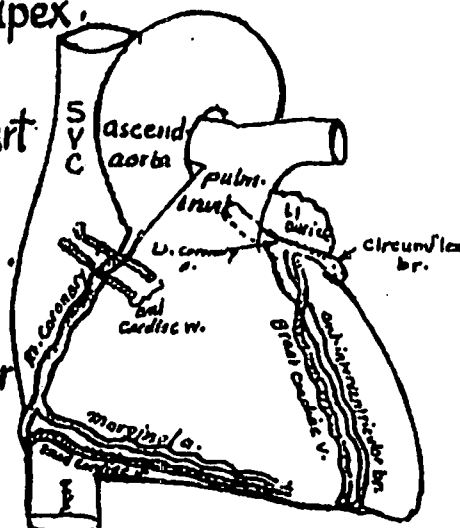


* Grooves on it :

- Ant. part of coronary (A-V) sulcus : runs obliquely from the Rt. side of root of pulmonary trunk to the lower end of Rt. border of the heart
- Ant. interventricular sulcus (I-V sulcus) : descends parallel to the Lt. border of the heart from the Lt. side of root of pulmonary trunk to the inf. border of the heart $1\frac{1}{2}$ cm to the Rt. of the apex.

* Vessels related to it :

- The Rt. coronary runs downwards in the ant. part of the coronary sulcus. One or 2 cardiac veins cross it in their way to open into the Rt. atrium.
- The marginal br. of Rt. coronary a. (accompanied by the small cardiac v.) run along the inf. border towards the apex
- The ant. interventricular br. of Lt. coronary a. (accompanied by the great cardiac v.) run in the ant. interventricular sulcus.



* Relations of the Sternocostal surface:

- Contents of the anterior mediastinum
 - remnants of thymus gland
 - sternopericardial ligaments & fat
 - internal mammary a.
- Ant. borders of both lungs & pleura
- Ant. thoracic wall
 - back of sternum
 - 2-6 C. Cartilages
 } separated from it by ant. borders of lungs & pleura, except at the cardiac notch, they are directly related.

Borders of the heart

(1) Upper border :

- * It is nearly a straight border formed by the 2 atria (mainly Lt. atrium)
- * It is hidden anteriorly by ascending Aorta, pulmonary trunk & S.V.C
- * The Rt. & Lt. pulmonary arteries run along it.

(2) Rt. border (sometimes called Rt. surface) :

- * It is nearly vertical & formed only by Rt. atrium
- * It is continuous above with S.V.C & below with I.V.C
- * It is related to mediastinal surface of Rt. pleura & lung but separated from them by pericardium, Rt. phrenic n. & pericardiophrenic vessels.

3) Lower border of the heart:

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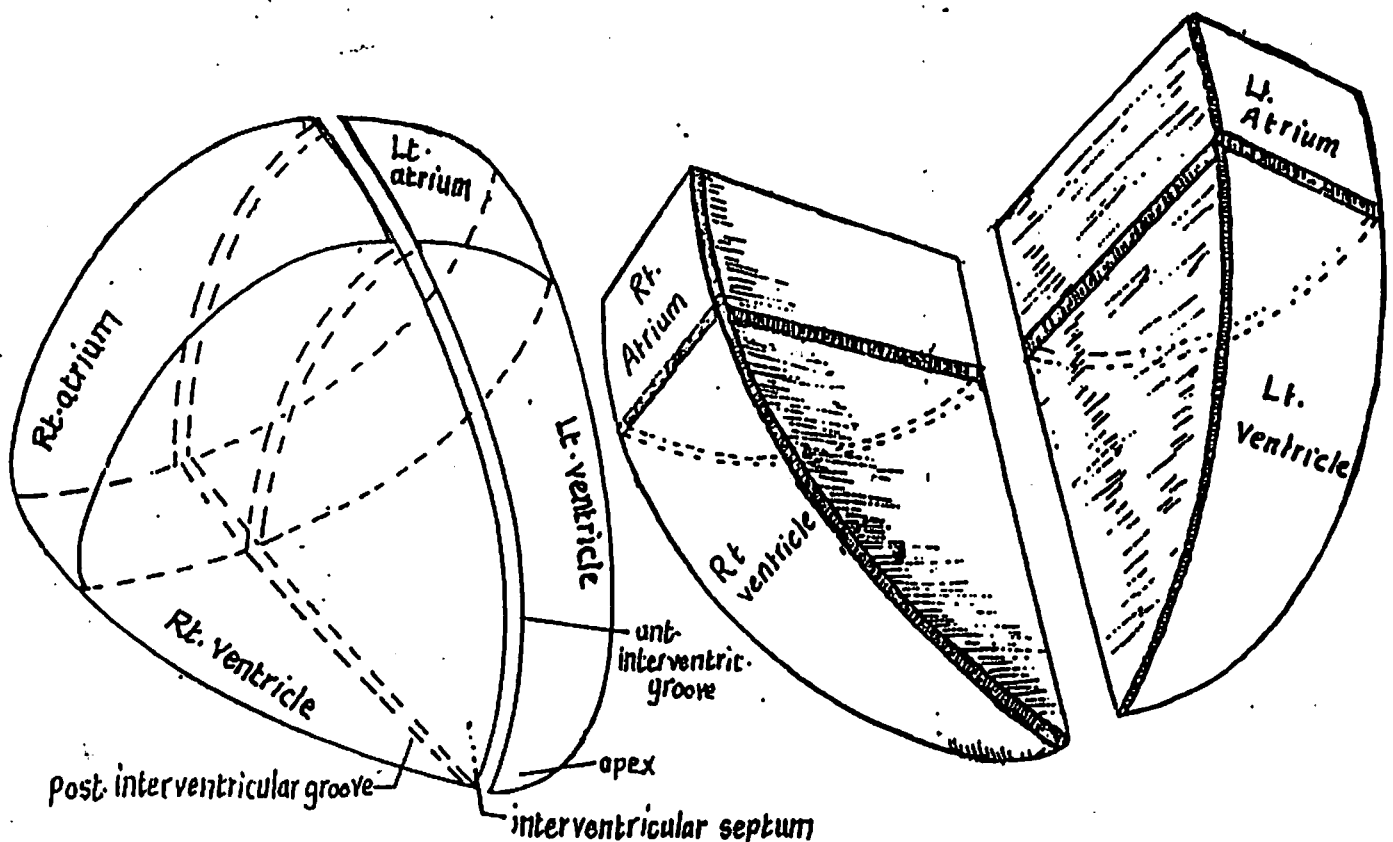
formed mainly by the Rt. ventricle & only small part by the Lt. ventricle ($\frac{1}{2}$)

(4) Left border (sometimes called the left surface) .

- * formed mainly by the Lt. ventricle & only a small part is formed by Lt. auricle .
- * related to mediastinal surface of Lt. lung & Lt. pleura but separated from them by pericardium , Lt. phrenic n. & pericardiophrenic vessels

The Internal Structure of the heart

- * The cone-shaped heart is divided into Rt. & Lt. halves by a longitudinal septum
- * This septum lies obliquely so that the Rt. $\frac{1}{2}$ of the heart lies anterior & to the Rt. while the Lt. half lies post. & to the Lt.
- * The Rt. $\frac{1}{2}$ receives & pumps deoxygenated blood , while the Lt. $\frac{1}{2}$ receives & pumps oxygenated blood .
- * Again , each half is divided by a transverse septum (containing a valve) into :
 - a) Post. $\frac{1}{3}$ (towards the base) representing the atrium (the receiving chamber)
 - b) Ant. $\frac{2}{3}$ (towards the apex) representing the ventricle (the pumping chamber)
- * Each atrium is connected to its corresponding ventricle by an opening called the 'Atrio-ventricular' (A-V) opening which is guarded by an atrio-ventricular valve

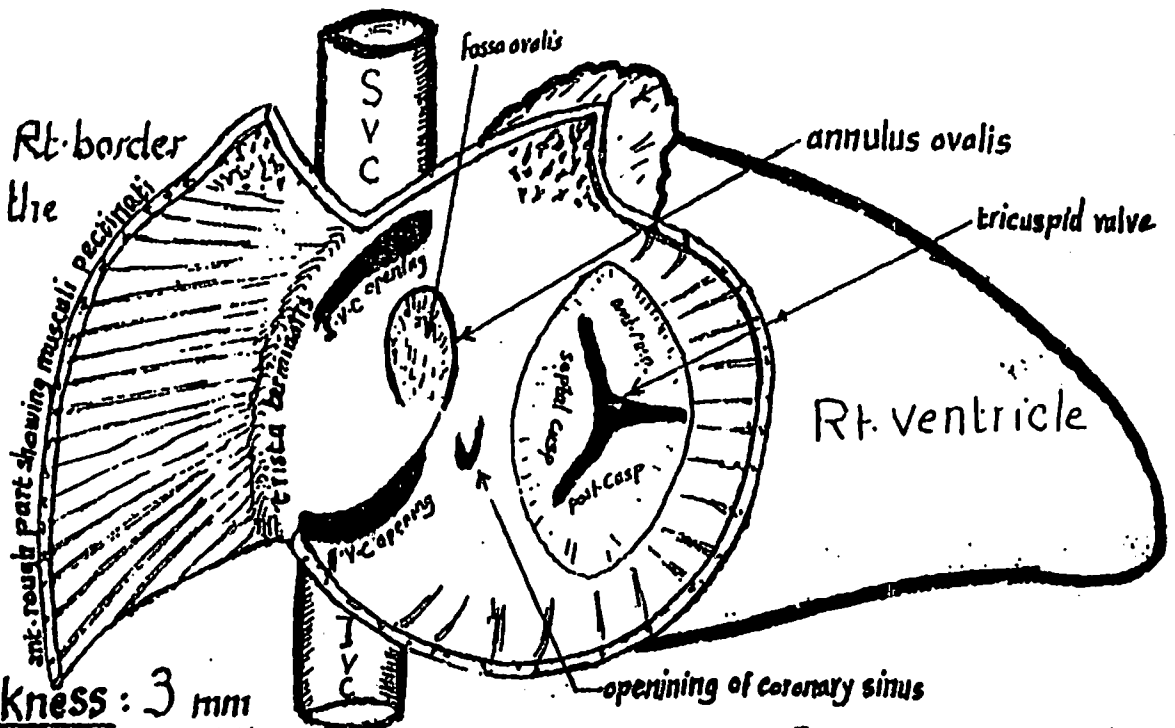


(1) Right Atrium

48

* Position:

It forms the Rt. border (surface) of the heart



* Wall thickness: 3 mm

* Parts: The interior of the Rt. atrium is divided into 2 parts :

- (1) Anterior rough part (derived from the atrium proper of the embryonic heart)
- (2) Posterior smooth part (" " " Sinus Venosus " " ")

* The 2 parts are separated from each other by a muscular ridge called "crista terminalis".

A] Crista terminalis :

- * It is a smooth longitudinal muscular ridge on the inner aspect of lat. wall of the Rt. atrium.
- * It extends from the Rt. margin of S.V.C. opening to the Rt. margin of the I.V.C. opening.
- * It corresponds to a faint groove on the outer surface called 'Sulcus Terminalis'

B] The Anterior part (atrium proper) :


- * It is continuous anteriorly with the right auricle
- * The walls of the atrium proper & its auricle are rough due to the presence of parallel muscular ridges called "Musculi pectinati"
- * These musculi pectinati extend forwards from the crista terminalis onto the lateral & anterior walls of Rt. atrium. They also form a dense network in the Rt. auricle.


C] The posterior part: (Sinus Venarum)


49

- This part represents the absorbed sinus venosus.

- It has smooth walls & receives the openings of veins returning the venous blood from all the body (except the lungs) i.e; S.V.C, I.V.C & coronary sinus.

1) Opening of the S.V.C  opens into the upper & post. part of Rt. atrium.
has no valves.

2) Opening of the I.V.C  opens into lower & post. part of Rt. atrium.
It is guarded by a rudimentary valve.

3) Opening of the coronary sinus  lies between opening of I.V.C & tricuspid valve
guarded by a valve.

N.B : Other veins open in the Rt. atrium :

* Venae Cordis minimi : numerous minute vv.

* Anterior cardiac vv. : 3-4 small vv.

D] The interatrial septum : shows an oval depression called "fossa ovalis" which lies above & to the Lt. of the opening for I.V.C.

The fossa ovalis is bounded above & on the sides by a raised margin called 'Annulus Ovalis'

N.B: 1) fossa ovalis represents Septum primum of the embryonic heart.

2) Annulus // // lower border of Septum Secundum of // //

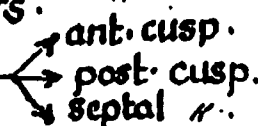
3) during foetal life, there is a gap between the 2 septa (foramen oval) which closes at birth.

E] The Rt. atrioventricular orifice (Tricuspid orifice)

• Directed forwards & medially, It admits tips of 3 fingers.

• Guarded by the tricuspid valve having 3 cusps

• Transmits blood from Rt. atrium to Rt. ventricle.

 ant. cusp.
post. cusp.
septal "

(2) Left Atrium

Position:- It lies behind & to the Lt. of the Rt. atrium forming the greater part of the base of heart.

- Its auricle (Lt. auricle) lies in front & to the left of the root of pulmonary trunk.

* parts :

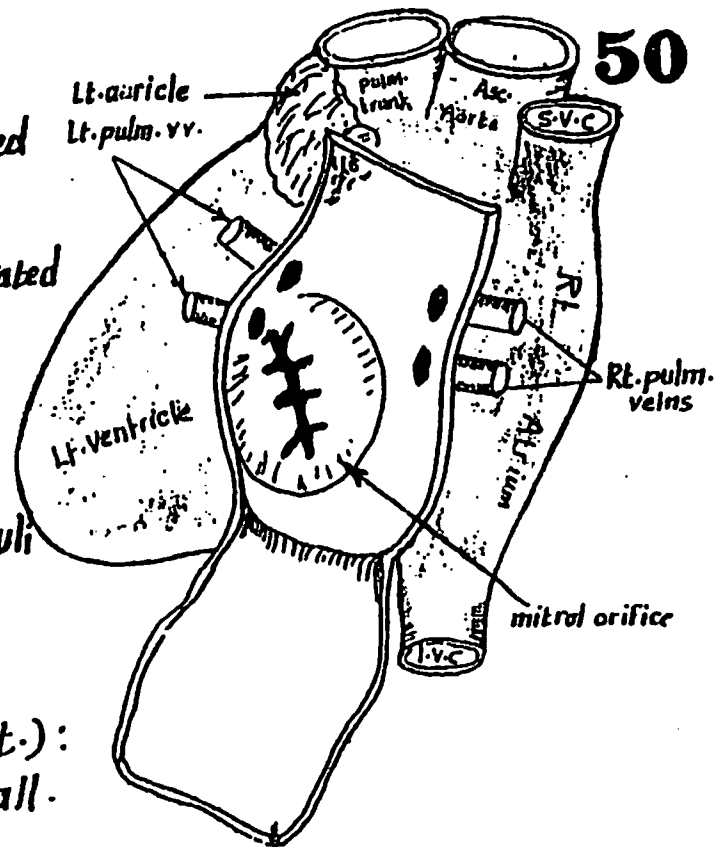
- (1) the ant. part + the auricle are derived from the atrium proper
- (2) the post. part : is formed by incorporated pulmonary veins.

* Cavity

the interior of the Lt. atrium shows a smooth wall except few & small muscoli pectinati in the Lt. auricle.

* Veins opening into it :

- (a) 4 pulmonary veins (2 Rt. & 2 Lt.) : in the upper part of its post. wall.
- (b) Venae cordis minimi



* Inter atrial Septum : may present a faint impression opposite f. ovale.

* The Lt. interventricular orifice (Mitral orifice) :

- it is guarded by the mitral valve which has 2 cusps (ant & post.)
- it admits the tips of 2 fingers

* Comparison between the 2 atria :

	Rt. Atrium	Lt. atrium
(1) position	forms Rt. border of heart & lies ant. & to the rt. of Lt. atrium	forms the greater part of the base of heart & lies behind & to the Lt. of Rt. atrium
(2) its auricle	overlaps the Rt. ant. aspect of root of pulmonary trunk	overlaps the Lt. ant. aspect of root of pulmonary trunk
(3) its cavity	is divided by the crista terminalis into post. smooth part & anterior rough part showing muscoli pectinati	its cavity is generally smooth except the auricle which shows few small muscoli pectinati
(4) inter-atrial septum	shows the fossa ovalis & annulus ovalis	may show a faint impression corresponding to fossa ovalis on the Rt. side
(5) veins draining into it	It receives deoxygenated blood from all body except lungs through: (1) S.V.C. (2) I.V.C (3) coronary sinus (4) ant. condiag vv. (5) venae cordis minimi	It receives oxygenated blood returning from lungs through the 2 Rt. & 2 Lt. pulm. vv. It also receives venae cordis minimi
(6) Exit of blood from it	Through the tricuspid valve which has 3 cusps & admits tips of 3 fingers and leads to Rt ventricle	through the mitral valve which has 2 cusps, admits tips of 2 fingers and leads to Lt ventricle

(3) Right Ventricle

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* Position: It forms:

$\frac{2}{3}$ of the sternocostal surface,

$\frac{1}{3}$ of the diaphragmatic

- It lies ant. & to the Lt. of Rt. atrium
& ant. & to the Rt. of Lt. ventricle.

* Wall Thickness: 9 mm

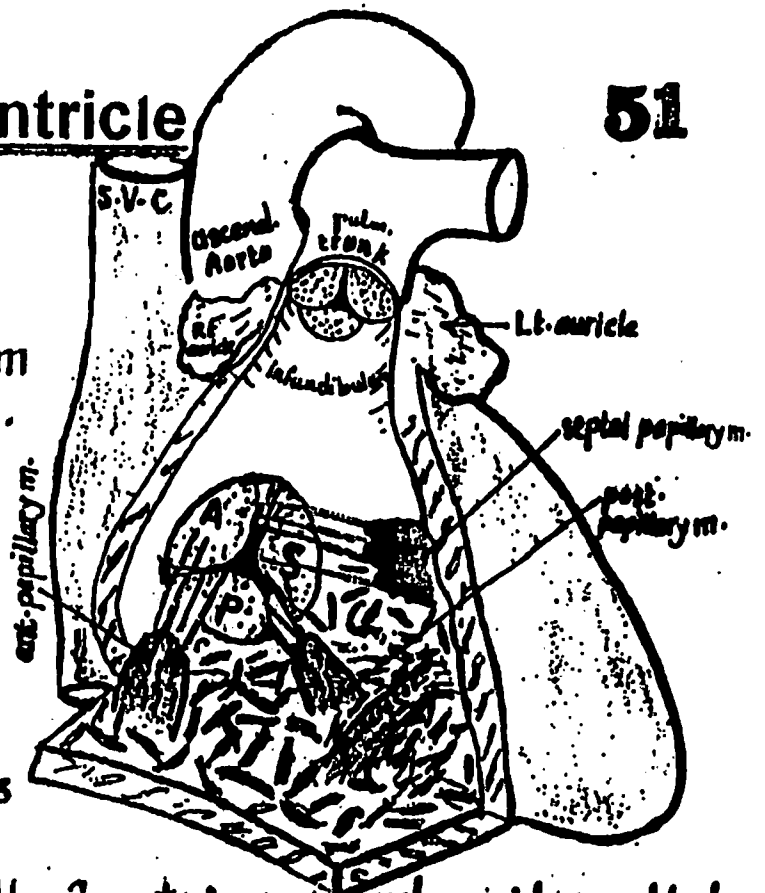
* Cross-section: Its cavity is
semilunar in cross-section.

* Its Cavity: is differentiated
into 2 parts:

A) Inflowing part: has rough walls

B) Outflowing // : // Smooth //

the demarcation line between the 2 parts is a muscular ridge called
'Supraventricular crest' (extending between the tricuspid & pulmonary orifices)



A) The inflowing part:

* lies below the level of the supraventricular crest

* receives the non-oxygenated blood coming from the Rt. ventricle
through the tricuspid orifice

* The walls are rough due to the presence of:

1) Trabeculae Carnei: They are coarse muscular bundles giving the
walls a sponge-like appearance.

2) Moderator band (septomarginal trabecula)

It is a muscular band crossing the lumen of the Rt. ventricle
& connecting the Interventricular septum with the ant. wall

The functions of this band are:

* It transmits the Rt. branch of A-V bundle

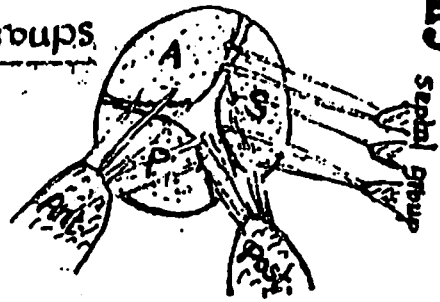
* It prevents overdistension of Rt. ventricle

3) Papillary muscles:

They are small conical muscular projections which protrude
into the cavity. Each papillary muscle gives rise to
chordae tendinae attached to 2 cusps of the tricuspid valve

The papillary muscles are arranged in 3 groups

- 1] Ant. papillary m. : arise from the ant. wall & sends chordae tendinae to the adjacent parts of ant. & post. cusps of tricuspid valve
- 2] Post. papillary m. : smaller, arises from the post. wall & sends chordae tendinae to the post. & septal cusps
- 3] Septal papillary m. : a number of small projections from the ventricular septum & sends chordae tendinae to the septal & ant. cusps.



(B) **The outflowing part** (Above the level of supra-ventricular crest)

- * It is called infundibulum because it forms a conical pouch leading to the pulmonary orifice
- * It has smooth walls (in contrast to the inflowing part which is rough)

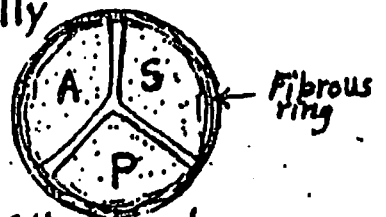
(c) **Orifices of the Rt. ventricle** :

(1) Tricuspid orifice & valve

- * Surface anatomy : lies behind the center of sternum opposite 4th intercostal space & directed forwards & medially

- * size : admits tips of 3 fingers.

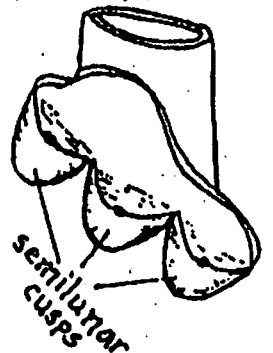
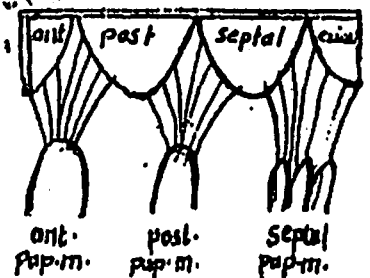
- * structure < fibrous ring.
3 cusps forming the valve.



a] The fibrous ring is formed by the fibrous skeleton of the heart

b] The cusps are 3 (ant., post. & septal)

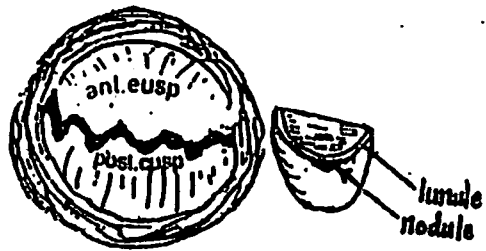
- each cusp is formed of 2 endothelial layers with a fibrous tissue layer inbetween
- the base of each cusp is attached to the fibrous ring
- the free border is attached to the chordae tendinae of papillary muscles.



(2) Pulmonary orifice & valve :

- * Surface anatomy : deep to the 3rd Lt. sternocostal junction
- * Size : 3 cm in diameter
- * structure : fibrous ring guarded by the pulmonary valve which has 3 semilunar cusps (one posterior & 2 anterior).

The margin of each cusp is called lunule & has its middle called "nodule"



(4) Left Ventricle

* Position: It forms $\frac{1}{3}$ of sternocostal surface & $\frac{2}{3}$ of the diaphragmatic surface. It lies post. & to the left of Rt. ventricle, ant. & to the left of left atrium.

* Wall Thickness: 3 times thicker than Rt. ventricle (i.e., 27 mm) because it pumps blood to the systemic circulation.

* Cross section: rounded.

* Its cavity: is differentiated into:

A] Rough inflowing part

B] Smooth outflowing part (vestibule)

A] The Inflowing rough part: presents:

1] Trabeculae carnei: like those of Rt. ventricle but differ in being more numerous & fine

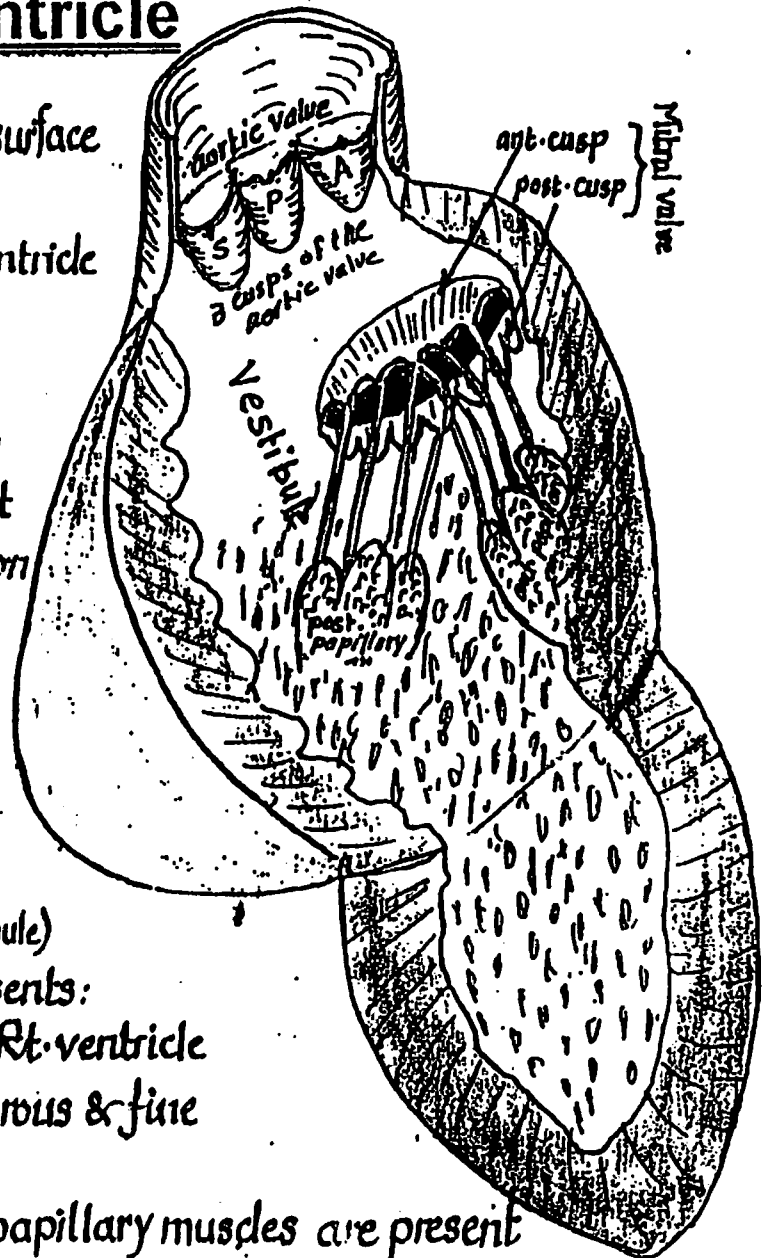
2] No moderator band

3] Papillary muscles: 2 large papillary muscles are present (ant. & post.) each sends chordae tendinae to the 2 cusps of the mitral valve.

B] The Outflowing smooth part (Aortic Vestibule):

- It lies below the Aortic orifice & has smooth walls

- Its walls are formed of fibrous tissue instead of muscular tissue to remain patent during ventricular systole, also it gives attachment to the myocardium.



c) Orifices of the Lt. Ventricle :

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1) Mitral orifice & valve :

- * Surface anatomy : deep to the 4th Lt. sternocostal junction
- * Direction : downwards & to the Lt.
- * Size : smaller than tricuspid. It admits only the tips of 2 fingers
- * Structure
 - ↗ fibrous ring : thicker than that of the tricuspid
 - ↘ 2 cusps forming the valve (ant. & post.)
- * The ant. cusp is larger than the post.
- * The free margin of each cusp receives chordae tendinae from the 2 papillary muscles of the Lt. ventricle.
- * The chordae tendinae are stronger than those of the Rt. ventricle.

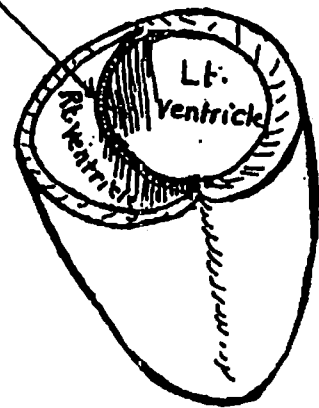


2) Aortic orifice & valve :

- * Surface anatomy : opposite the Lt. 3rd intercostal space behind Lt. border of sternum
- * Size : 2.5 cm in diameter
- * Structure : As the pulmonary orifice & valve, but its cusps are arranged as one anterior & 2 posterior.

The Interventricular Septum

- * It is the septum which separates the 2 ventricles
- * Position : It is oblique in position being concave towards Lt. ventricle & convex towards Rt. ventricle
- * Its ant. border corresponds to the ant. interventricular groove on the sternocostal surface of the heart
- * Its post. border corresponds to the post. interventricular groove on the diaphragmatic surface of the heart
- * Parts
 - ↗ 1) Muscular part : the lower large thick part
 - ↘ 2) Membranous : the upper small oval area (common site for Ventricular Septal defect)



Structure of the heart wall

The heart wall consists of 3 layers as follows (from outside inwards) :

- 1) Epicardium : the thin smooth visceral layer of serous pericardium.
- 2) Myocardium : the main bulk of the heart wall consisting of:
 - (a) Cardiac muscle fibres (atrial & ventricular) attached to the fibrous skeleton
 - (b) Fibrous skeleton of the heart including the fibrous rings (see page 55).
 - (c) the conducting system formed of specialized muscle fibres (see page 56).
- 3) Endocardium : smooth thin layer lining the cardiac chambers & forming valves.

The Fibrous skeleton of the heart

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* Definition: it is the fibrous tissue which surrounds the atrio-ventricular orifices & the origins of the big arteries (aorta & pulmonary trunk).

* Structure: it is formed of the following components:

(1) the Lt. atrioventricular ring around the mitral orifice

(2) » Rt. » » » » tricuspid »

N.B: (a) both rings form 8-shaped structure

(b) the Rt. ring is larger but weaker than the Lt. ring.

(c) the 8-shaped structure is attached to the fibrous part of the interventricular septum as well as the musculature of the atria & the ventricles

(3) the fibrous ring of the aortic orifice

(4) » » » » » pulmonary orifice

(5) the Rt. fibrous trigone:

is a large mass of fibrous tissue between the aortic & tricuspid rings.

(6) the Lt. fibrous trigone:

is a small mass of fibrous tissue » » aortic & mitral rings.

(7) the tendon of the infundibulum:

connects the post. surface of the infundibulum to the aortic ring.

* Functions of the fibrous skeleton of the heart:

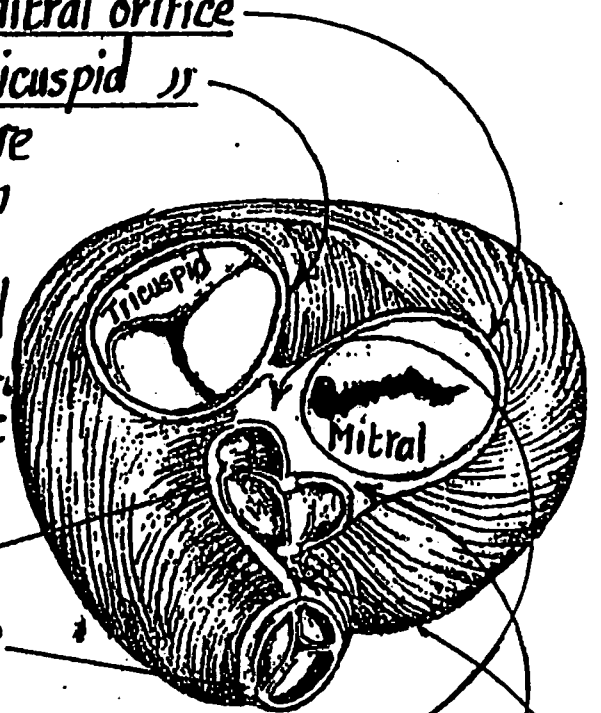
(1) it provides attachment to the ventricular & atrial musculature

(2) it » a strong base for attachment of fibrous cores of the valve cusps thus keeping the cardiac valves competent.

(3) it ensures electrophysiological discontinuity between the atrial & the ventricular myocardium.

N.B: there is no muscular continuity between the atria & ventricles across the rings except for the atrioventricular bundle of His.

(4) It maintains the position of the heart inside the pericardium.



	Right Ventricle	Left Ventricle
1- Position	Ant. & to the Rt. of Lt. Ventricle	Post. & to the Lt. of Rt. Ventricle
2- Surfaces formed by it	it forms $\frac{2}{3}$ of sternocostal surface & $\frac{1}{3}$ » diaphragmatic surface	it forms $\frac{1}{3}$ of the sternocostal surface & $\frac{2}{3}$ » » diaphragmatic surface
3- Borders formed by it	it forms nearly all the lower border of the heart	it forms the apex & the Lt. border of the heart.
4- cross section	semilunar	circular
5- Wall thickness	9 mm.	27 mm (3 times thicker.)
6- Trabeculi carni	few & rough	numerous & fine.
7- moderator band	present	absent
8- papillary muscles	3 (ant., post. & septal)	2 larger (ant. & post.)
9- smooth part	called infundibulum of pulmonary trunk	called vestibule of the aorta
10- orifices	(1) the Rt. atrioventricular (tricuspid): - wider in diameter (admits 3 fingers) - has 3 cusps (ant., post. & septal) (2) the pulmonary orifice & valve: has 3 semilunar cusps (1 post. & 2 ant.)	(1) the Lt. atrioventricular (Mitral): - smaller in diameter (admits 2 fingers) - has 2 cusps (ant. & post.) (2) the aortic orifice & valve: has 3 semilunar cusps: 2 post. & 1 ant.

Conducting System of the heart

* **Structure**: Consists of modified cardiac muscle fibres which are responsible for the initiation & propagation of the cardiac impulse

* **Parts**: the conducting system consists of:

(1) **Sino-atrial (S-A) node**:

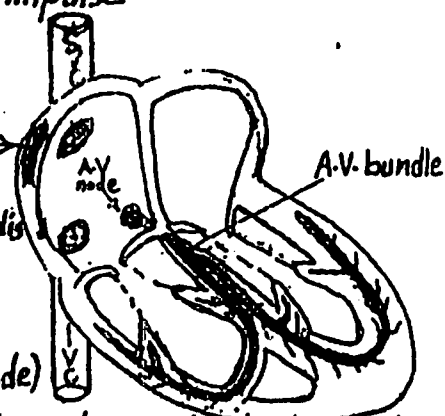
- site: in the lat. wall of the Rt. atrium behind the opening of S.V.C (mainly in the post. border of crista terminalis)
- Shape & size: crescentic, 1 cm long x 3 mm. wide
- Function: initiation of the cardiac impulse (pace maker)

(2) **Atrio-ventricular (A-V) node**: (smaller than S-A node)

site: in the in the lower & dorsal part of atrial septum just above the opening of coronary sinus.

(3) **Atrio-Ventricular (A-V) bundle**: the only connection between atria & ventricles

- arises from the A-V node, descends deep to the fibrous ring of the tricuspid orifice to reach the membranous part of the interventricular septum where it divides into Rt. & Lt. branches. It transmits the cardiac impulse from the atria to the ventricles.



4) Rt. branch of A-V bundle :

- * runs in the muscular part of I-V septum close to the cavity of Rt. ventricle
- * then it passes through the moderator band to reach the base of ant. papillary m.
- * It ends by dividing into a plexus of purkinji fibers which are distributed to all parts of Rt. ventricle.

5) Lt. branch of A-V bundle :

- * runs in the muscular part of the I-V septum (beneath the endocardium of Lt. ventricle) towards the apex.
- * it ends by dividing into purkinji fibers distributed to all parts of Lt. ventricle

* Arterial Supply of the Conducting System (mainly From Rt. Coronary a.):

(a) S-A node : 60 % by Rt. Coronary a. & 40 % by Lt. Coronary a.

(b) A-V node : 80 % " " " " 20 % " " " "

(c) A-V bundle : by the Rt. coronary a.

(d) Rt. bundle branch : by Rt. coronary a.

(e) Lt. " " : by Rt. & Lt. coronary arteries.

Arterial Supply of the heart

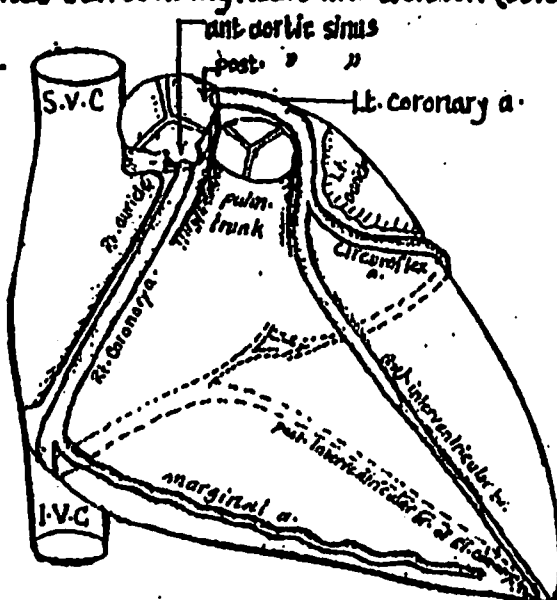
- * The heart is supplied by 2 coronary arteries (Rt. & Lt.)
- * They arise from the ascending aorta
- * The coronary ac. & their main branches lie in the A-V & I-V grooves
- * They are called coronary because they form an arterial circle in the A-V sulcus & a loop in the ant. & post. I-V grooves thus surrounding heart like a crown (corona)

1) Rt. coronary artery

- * Origin: Arises from the ant. Aortic sinus of ascending aorta.

* Course:

- (1) It runs forwards between the root of the pulmonary trunk & the Rt. auricle to reach the coronary sulcus on the ant. surface of the heart.
 - (2) Then it runs downwards & to the right in the coronary sulcus to reach the inferior border of the heart
 - (3) Finally, it turns backwards to reach the post. part of the coronary sulcus (which separates base of heart from the diaphragmatic surface)
- * Termination: It ends by anastomosing with the circumflex br. of Lt. coronary a.
 - * Branches:
 - 1) Marginal a. : arises from the Rt. coronary a. before it turns backwards
 - It runs along the inf. border of the heart towards the apex.
 - It supplies the Rt. ventricle.



(2) Posterior (inferior) interventricular br. : it runs in the post. (inf.) interventricular sulcus. It supplies both ventricles + the post. $\frac{1}{3}$ of the ventricular septum. 58

(3) Small unnamed branches to supply \leftarrow the roots of pulm. trunk & Aorta.
the Rt. atrium including S.A node.

(4) Anastomotic branches with the circumflex br. of Lt. coronary a.

(2) Lt. Coronary a.

* Origin: from the Lt. post. aortic sinus of the ascending aorta (It is larger than Rt. coronary area)

* Course:

It runs forwards between the root of pulmonary trunk & Lt. auricle to reach the upper end of the ant. interventricular sulcus where it ends by dividing into the ant. interventricular a. & the circumflex a.

* Branches:

1) Twigs to the ascending aorta & pulmonary trunk.

2) Branch to the S.A node (arises at the beginning of the artery).

3) Anterior interventricular a. (the larger of the 2 terminal branches) :

* It descends in the ant. interventricular sulcus to reach the inf. border of the heart near the apex.

* Then it turns backwards to reach the inf. interventricular sulcus to end by anastomosing with the inf. (post.) interventricular br. of Rt. coronary a.

* It supplies branches to both ventricles + the ant. $\frac{2}{3}$ of the ventricular septum

4) Circumflex a.

* It runs to the Lt. in the coronary sulcus undercover of Lt. auricle.

* Then it turns backwards curving around the Lt. border of the heart to reach the post. part of coronary sulcus where it ends by anastomosing with the Rt. coronary a.

* It supplies the Lt. atrium & base of Lt. ventricle.

Anastomosis between branches of coronary aa.

* The anastomosis between the small branches of coronary aa. is poor especially in young age.

* As age advances, the anastomosis increases but still it is not adequate to form an efficient collateral circulation if a large a. is obstructed.

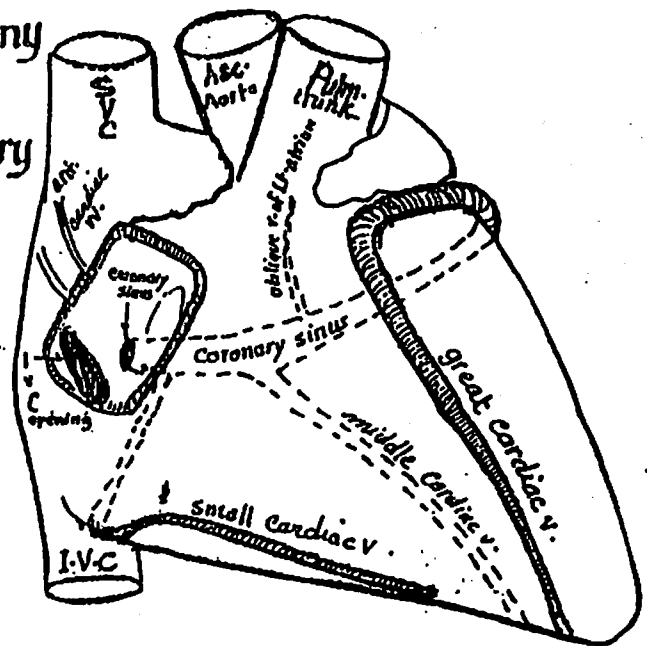
- * Most of the veins of the heart accompany arteries
- * Most of the cardiac vv. end in the coronary sinus

Coronary Sinus

- * It is a wide venous channel about 4 cm long draining most of cardiac vv.
- * Site : it lies in the post. part of the coronary sulcus between base of the heart & the diaphragmatic surface.

- * Termination : It opens into the cavity of Rt. atrium just above & to the left of the opening of I.V.C (its opening has a valve)

- * Tributaries :
 - 1- Great cardiac vein
 - 2- middle cardiac vein
 - 3- Small cardiac vein
 - 4- Oblique v. of Lt. atrium



(1) The great cardiac vein :

- * Begins on the ant. surface of the heart near the apex
- * Ascends in the ant. interventricular sulcus accompanying ant. interventricular a.
- * At the upper end of the ant. interventricular sulcus it turns backwards around the Lt. border of the heart (accompanying the circumflex a.) to reach the post. part of the coronary sinus
- * It ends by joining the left end of the coronary sinus

(2) The Middle Cardiac vein :

- * Begins near the apex of the heart on the inf. surface.
- * Runs upwards & backwards in the post. interventricular sulcus (accompanying post. interventricular a.)
- * It ends by joining the coronary sinus at its middle

(3) The Small Cardiac vein :

- * Begins near the apex of the heart on the ant. surface.
- * It runs upwards accompanying the marginal br. of Rt. coronary a.

- tilt it reaches the ant. part of the coronary sulcus.
 * then it turns backwards accompanying the Rt. coronary a. to join the Rt. end of the coronary sinus.

4) Oblique V. of Lt. atrium:

It is a small vein which descends obliquely on the back of Lt. atrium to end in the coronary sinus

Veins which do not open into the Coronary Sinus:

- 1) ant. Cardiac veins: 3-4 veins which drain the ant. wall of Rt. ventricle & drain directly into the Rt. atrium
- 2) Venae Cordis minimi: are minute veins present in the walls of each chamber of the heart & drain directly into the cavity of each chamber.

Nerve Supply of the heart

- 1) Type of nerves supplying the heart: The heart is supplied by autonomic (sympathetic & parasympathetic fibres) via the cardiac plexus of nerves (Superficial C. plexus & deep cardiac plexus).
- 2) Function:
 - a) They help to control the rate & strength of the heart beat
 (sympathetic increase them, while parasympathetic decreases them)
 - b) The pain impulses are conducted by afferent fibres that run with the sympathetic

N.B: The autonomic nn. supplying the heart are not responsible for initiation & propagation of the cardiac impulse.
- 3) Origin of the autonomic fibres:
 - (A) The Sympathetic nerves (6 pairs of nn.)

• In the neck 3 pairs of symp. branches from

↗	Rt. & Lt. Sup. symp. ganglia
→	Rt. & Lt. middle. " "
↘	Rt. & Lt. inf. " "

• In the Thorax 3 pairs of Symp. branches from

↗	Rt. & Lt. 2nd ganglia	} of the thoracic part of Symp. chain
→	Rt. & Lt. 3rd "	
↘	Rt. & Lt. 4th "	

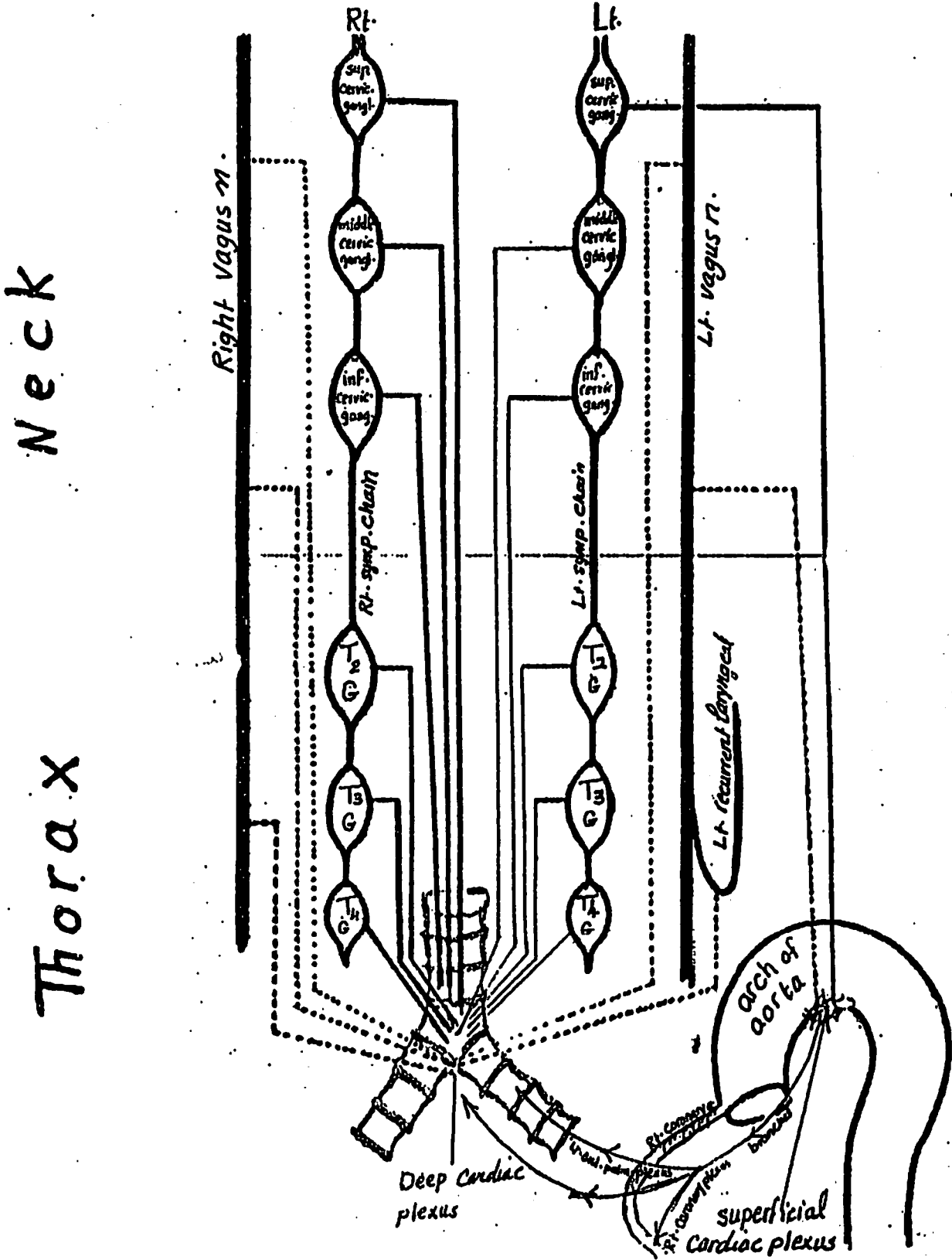
(B) The Parasympathetic nerves (3 pairs)

In the neck:

2 pairs → Rt. & Lt. upper cervical cardiac branches (from Rt. & Lt. Vagus).
 → Rt. & Lt. lower " " " " (" " " " ").

In the Thorax:

1 pair → Rt. br. from Rt. vagus
 → Lt. br. " Lt. recurrent laryngeal n.



(1) Superficial Cardiac Plexus

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* Site: below the arch of aorta & on the Rt. side of ligamentum arteriosum.

* Formation: It is formed by 2 autonomic nerves :

- (1) Sup. cervical cardiac br. of Lt. Symp. chain.
- (2) Inf. " " " " Lt. Vagus nerve.

* Branches: It gives branches to :

- 1) The deep cardiac plexus
- 2) " Rt. coronary plexus around Rt. coronary a. → to the heart
- 3) " Lt. ant. pulm. plexus in front of Lt. bronchus.

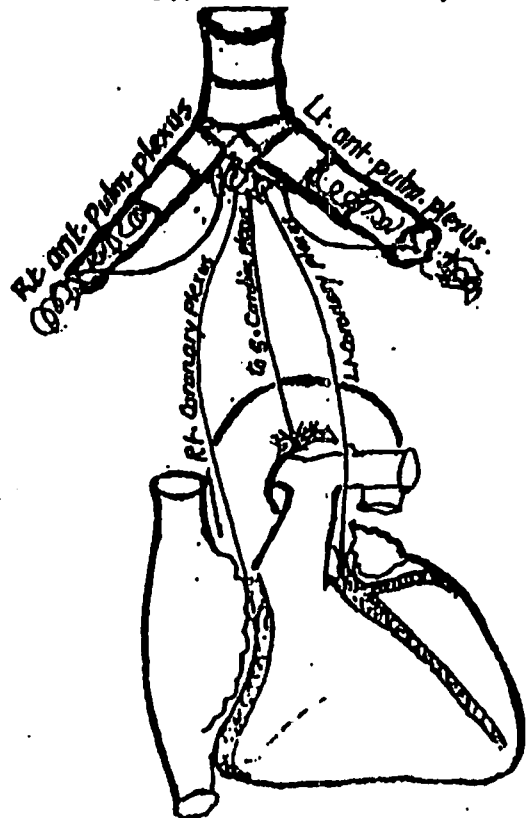
(2) Deep Cardiac Plexus

* Site: lies in front of tracheal bifurcation (deep to the arch of aorta).

* Formation: by all cardiac branches arising from the 2 symp. chains & 2 vagi except the 2 branches which join the Superficial plexus i.e; it is formed by 16 cardiac branches. It also receives br. from the superficial cardiac plexus.

* Branches:

- 1) To the Rt. coronary plexus.
- 2) " " Lt. " "
- 3) " " Rt. ant. pulmonary plexus.
- 4) " " Lt. ant. pulmonary plexus.
- 5) br. to the Superficial cardiac plexus.



1. Pulmonary Trunk

It is a large arterial trunk which transmits Non-Oxygenated blood from Rt. ventricle to the lungs. It is 5 cm long & 3 cm in diameter.

- * Origin: from the summit of the infundibulum of Rt. ventricle behind the sternal end of the 3rd Lt. costal cartilage
- * Course: It passes upwards, backwards & to the Lt. winding around the Lt. side of ascending aorta (being 1st in front, then on the Lt. side of asc. aorta).
- * Termination: It ends immediately below the concavity of the aortic arch (at the level of the disc between T₄, T₅). The bifurcation lies in front of oesophagus but separated from it by the trachea.
- * Relations:

(A) Posterior relations:

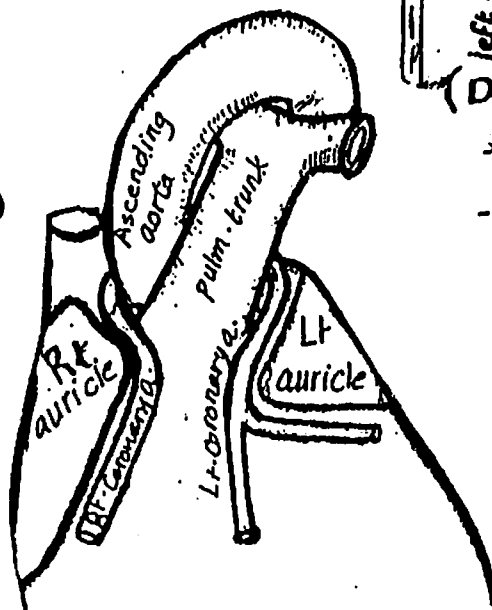
- 1) Its lower part is related to ascending aorta & Lt. coronary a.
- 2) Its upper " " " " Lt. atrium (separated from it by transverse sinus of pericardium).

(B) Anterior relations:

ant. border of Lt. lung & pleura separating the pulmonary trunk from 2nd intercostal space & Lt. border of sternum.

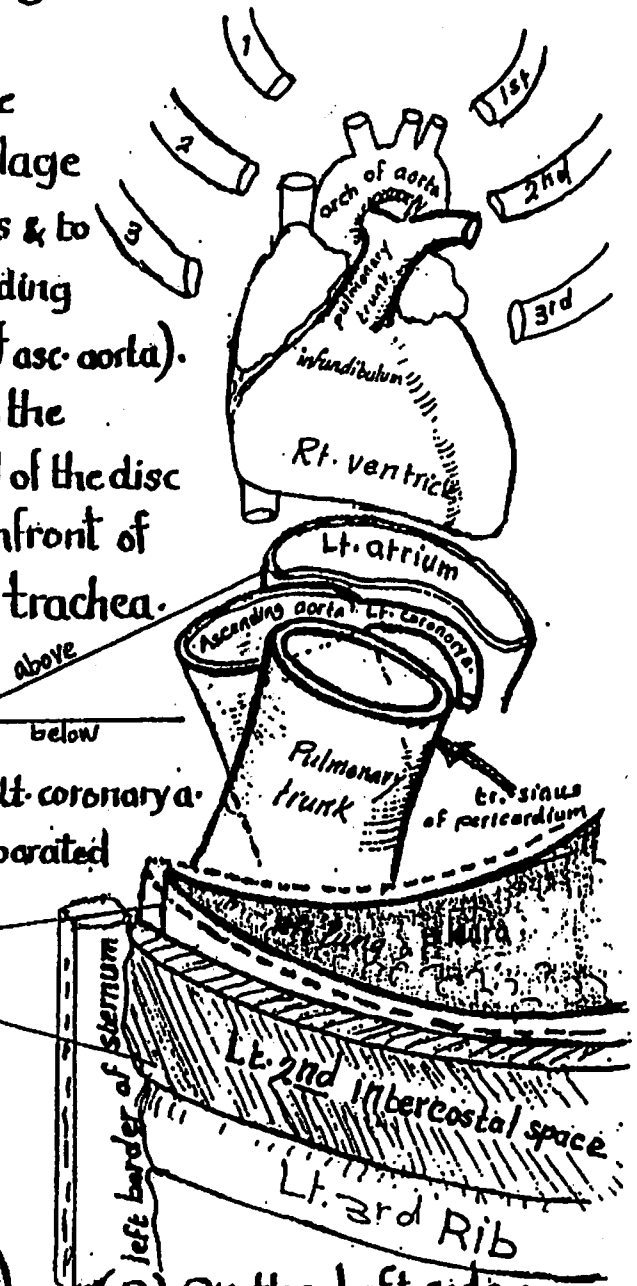
(C) On the Right side:

- 1] Rt. auricle & Rt. coronary a. (below)
- 2] Ascending aorta (above).



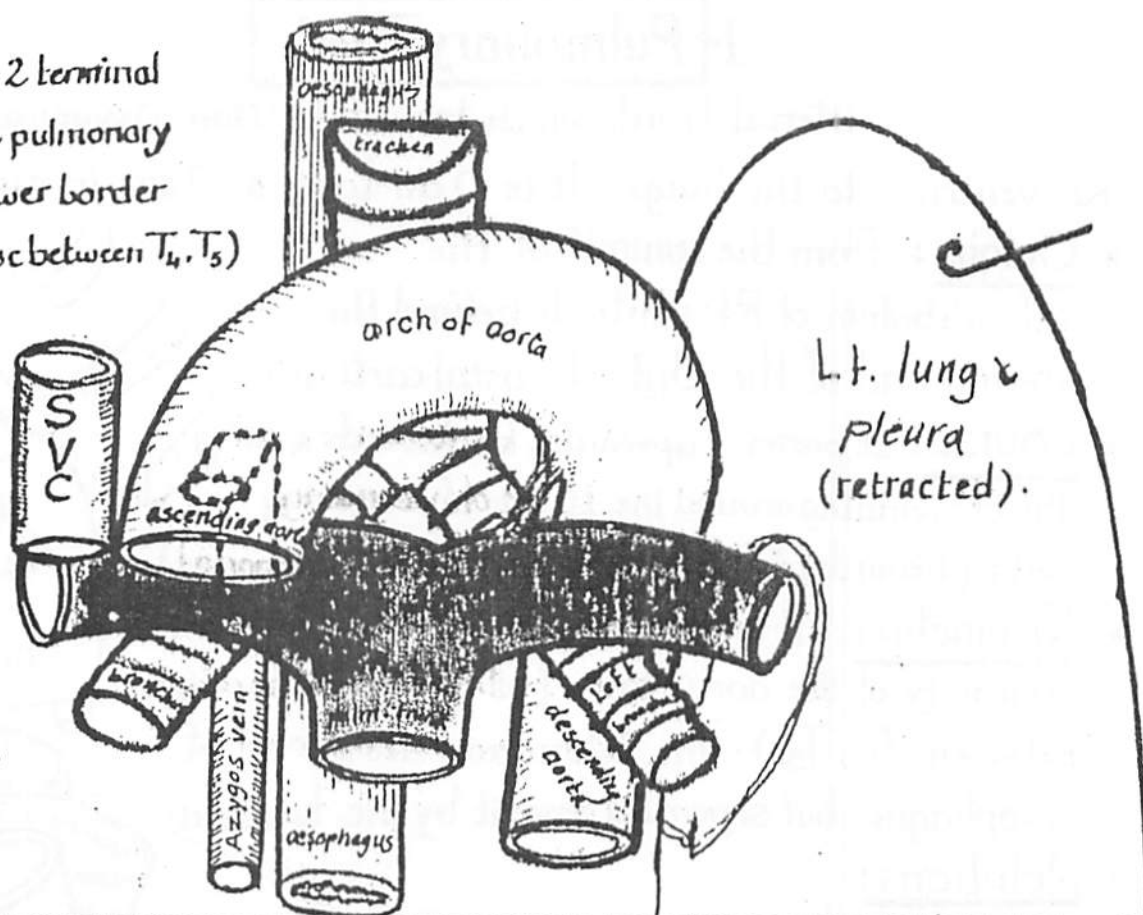
(D) On the Left side:

- 1] Left auricle &
- Lt. coronary artery.



* Origin :

They arise as the 2 terminal branches of the pulmonary trunk at the lower border of aortic arch (disc between T_4, T_5)



	Rt. Pulmonary artery	Lt. Pulmonary artery
Size	Longer & wider	shorter & narrower
Course	passes transversely to the right below the arch of azygos vein to reach hilum of Rt. lung	runs transversely to the left below arch of aorta to which it is attached by ligamentum arteriosum
Post. relations	Rt. main bronchus, oesophagus	Lt. main bronchus, descending aorta
Ant. relations	- Ascending aorta - S.V.C - Rt. phrenic n. - Upper Rt. pulm. vein	- overlapped by Lt. pleura & lung - Lt. phrenic n.
Termination	divides into 2 branches : - A smaller br. to the superior lobe - A large br. to the middle & inf. lobes	divides into 2 branches - one for the upper lobe - " " " lower lobe
Connection to aortic arch		connected to the lower surface of arch of aorta by ligamentum arteriosum

2- Ascending Aorta

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* Origin:

arises from the vestibule of Lt. ventricle behind the left border of the sternum at the level of the Lt. 3rd intercostal space.

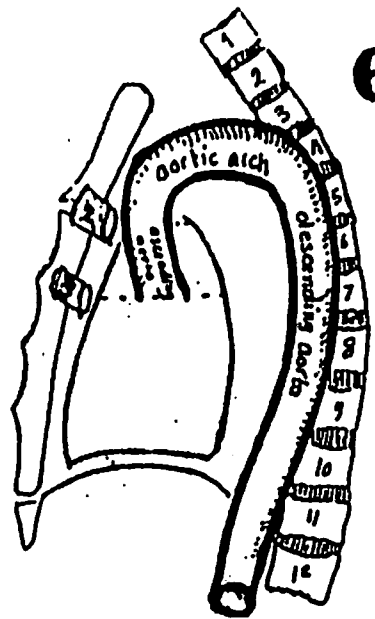
* Course:

It passes upwards, forwards & to the Rt. behind the upper part of the body of sternum (It lies inside fibrous pericardium)

* Termination:

behind the Rt. 2nd sternocostal junction by becoming arch of aorta

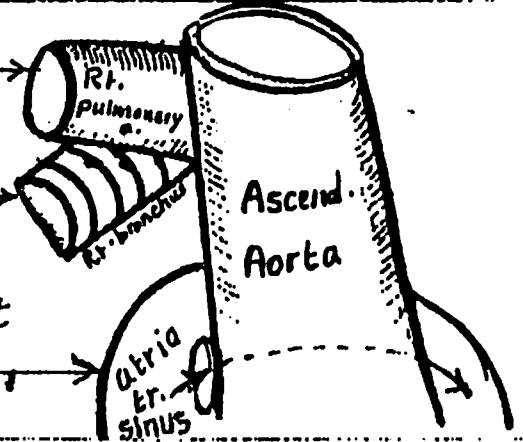
* Relations:



- (1) Anteriorly
- above: ant. margins of Rt. lung & pleura, remnant of thymus separating it from the sternum.
 - below: infundibulum of Rt. ventricle
 - root of pulmonary trunk
 - Rt. auricle

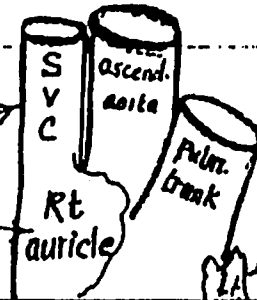


- (2) Posteriorly
- above: Rt. pulmonary artery separating it from the Rt. bronchus.
 - below: transverse sinus of the pericardium separating it from the 2. atria.



(3) on the Rt. side:

- above: S.V.C
- below: Rt. auricle



(4) on the Lt. side:

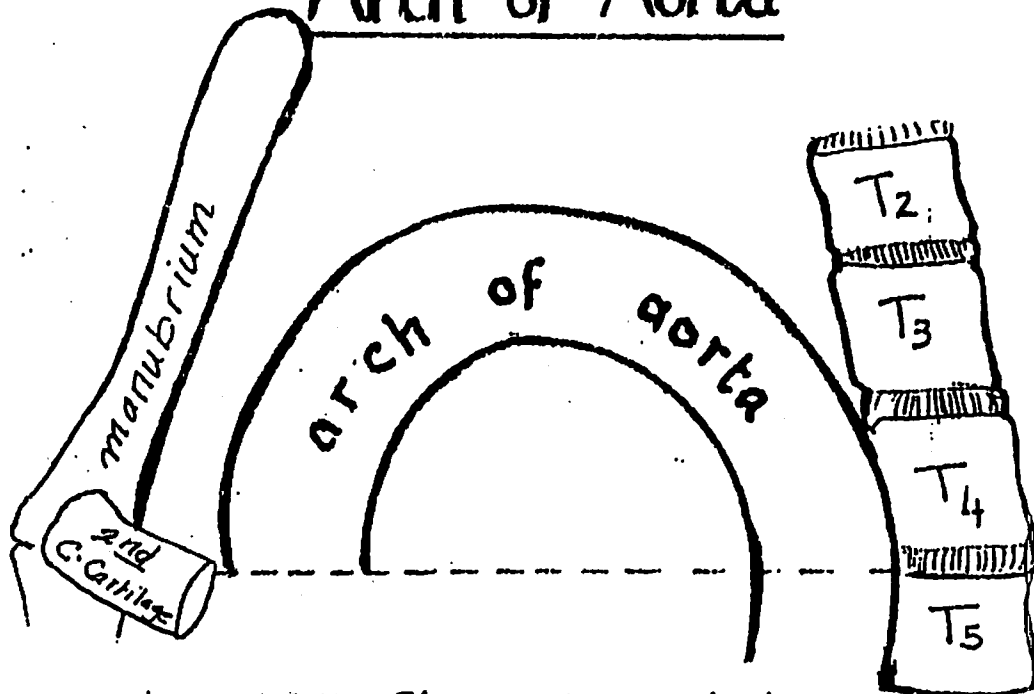
- pulmonary trunk (above)
- Lt. auricle (below)

* Branches: the Rt. & Lt. Coronary arteries:

- the ascending aorta has 3 dilatations called aortic sinuses (one ant. & 2 post.) lying immediately above the 3 cusps of the aortic valve.
- the Rt. coronary a. arises from the ant. aortic sinus
- the Lt. " " " " " Lt. post. aortic sinus

Arch of Aorta

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* Beginning : behind the Rt. 2nd sternocostal junction as a continuation of ascending aorta.

* Course : It runs an arched course behind the lower $\frac{1}{2}$ of manubrium

* It passes upwards, backwards & to the left then bends downwards

* During this course, it presents 2 curvatures :-

- one convex upwards

- the other convex anteriorly & to the left

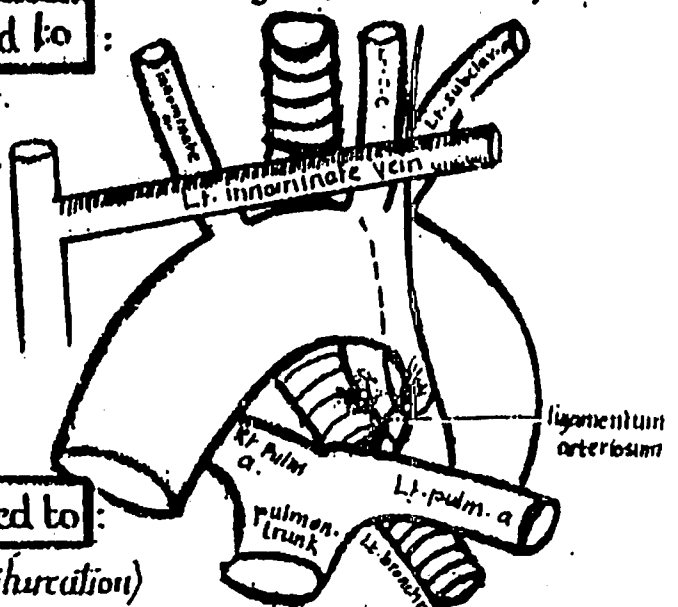
* Termination : On the left side of the disc between T₄ & T₅ by becoming the descending aorta.

* Relations : the arch of aorta has 4 aspects

- upper convex aspect
- lower concave aspect
- Left anterior aspect
- right posterior aspect

1- The upper convex aspect is related to :

- a. 3 arteries
- innominate a.
 - Lt. common carotid a. (arising from it)
 - Lt. subclavian a.
- b. Lt. innominate v. crosses in front of the 3 arteries from Lt. to Rt. along the upper border of the aortic arch



2- The lower concave aspect is related to :

- a. 3 arteries
- Pulmonary trunk (its bifurcation)
 - Rt. pulmonary a.
 - Lt. pulmonary a. & Ligamentum arteriosum with
- b. Lt. main bronchus
- superficial cardiac plexus on its Rt. side.
- Lt. recurrent laryngeal n. on its Lt. side.

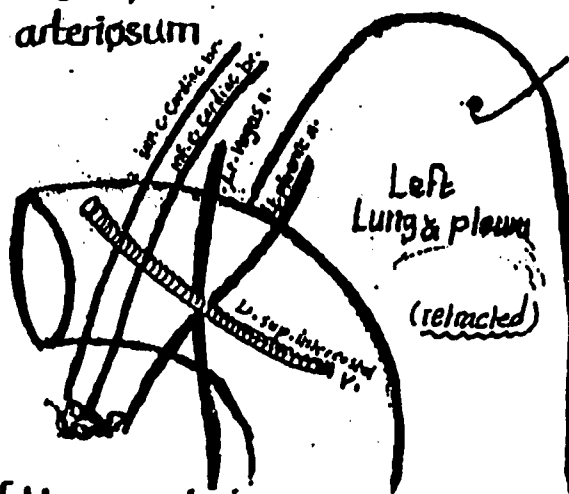
N.B (1) The superficial cardiac plexus lies below the arch of aorta on the Rt. side of ligamentum arteriosum. **67**

(2) The Lt. recurrent laryngeal br. of Lt. vagus passes below the arch on the Lt. side of the ligamentum arteriosum

3- The Lt. Anterior aspect :

is related to the Lt. mediastinal pleura & lung but separated from it by 5 structures : 4 nerves & 1 vein

- 4 nerves
- Lt. phrenic n.
 - Lt. vagus n.
 - Sup. cervical cardiac br. of Lt. symp. chain
 - Inf. " " " " Lt. vagus n.

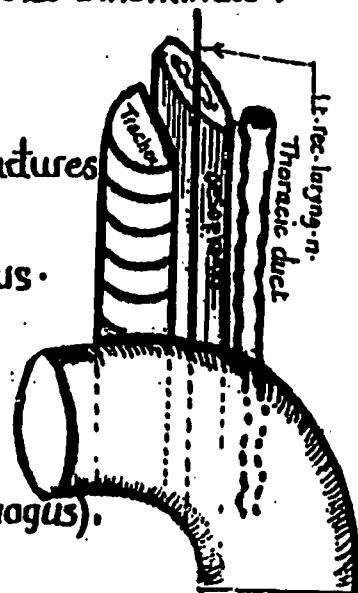


One vein : Lt. sup. intercostal v. : crosses superficial to the previous 4 nn. on its way to open into the Lt. innominate v.

4- The Rt. Posterior aspect :

is related to the 4 longitudinal prevertebral structures of the superior mediastinum :-

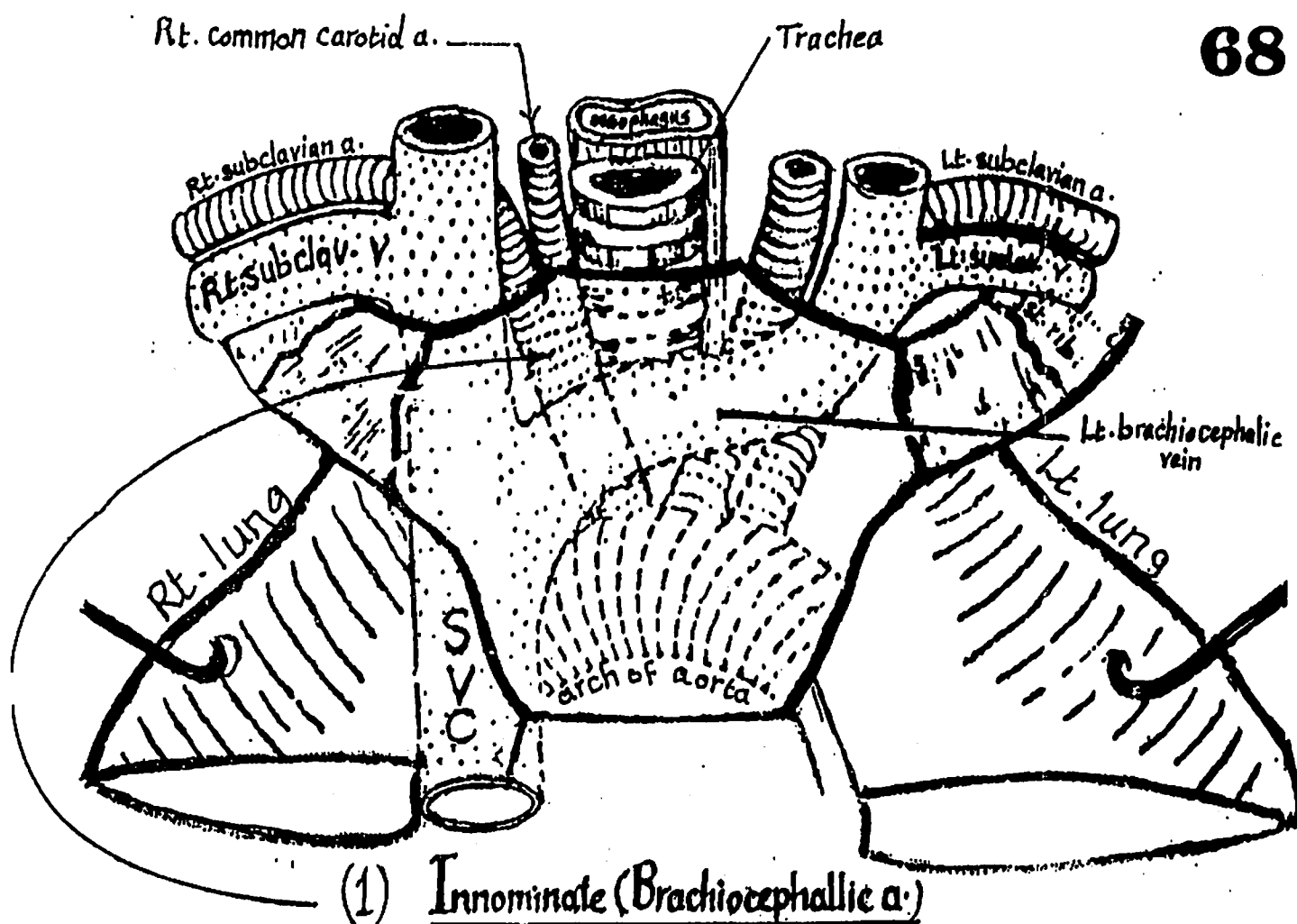
- 1) Trachea (bifurcation) & deep cardiac plexus.
- 2) Oesophagus (Lt. border).
- 3) Lt. recurrent laryngeal n. (in the groove between trachea & oesophagus).
- 4) Thoracic duct (behind Lt. border of oesophagus).



Branches of Arch of Aorta

- 1) Innominate (Brachiocephalic) a.
 - 2) Lt. common carotid artery
 - 3) Lt. subclavian artery
- } 3 large branches that arise from the upper convex aspect of the arch & pass to head, neck & upper limbs
- 4) Thyroid ima artery : a very small br. which may arise from the arch or from innominate a. & ascends to supply the thyroid gland in the neck.

* CLINICALLY IMPORTANT POINTS RELATED TO ARCH OF AORTA : see page 99



It is the largest br. of arch of aorta.

* Origin: arises from aortic arch opposite the center of manubrium (in front of trachea).

* Course: It passes upwards, backwards & to the Rt.

* End: It ends behind the upper border of Rt. sternoclavicular joint by dividing into:
- Rt. common carotid a. - Rt. subclavian a.

* Relations:

- 1] Anteriorly: manubrium sterni, separated from it by
 - sternohyoid & sternothyroid
 - remnant of thymus gland
 - Lt. innominate vein
- 2] Posteriorly
 - Trachea (below).
 - Rt. pleura & lung (above).
- 3] Rt. side
 - Rt. innominate v. & S.V.C separating it from:
 - Rt. lung & pleura.
- 4] Lt. side
 - Origin of Lt. common carotid a. (below)
 - Trachea (above)

2- Lt. Common Carotid artery

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* Origin: from the arch of aorta just to the left of the origin of the brachiocephalic a. & in front of the trachea.

* Course: it passes upwards, backwards & to the left to enter the neck behind the Lt. sternoclavicular joint where it continues upwards in the neck inside the carotid sheath.

* Relations in the thorax:

(A) Anteriorly: manubrium, separated from it by:

- (1) sternohyoid & sternothyroid muscles
- (2) left brachiocephalic Vein
- (3) remains of thymus gland
- (4) ant. border of Rt. lung & pleura.

(B) Posteriorly:

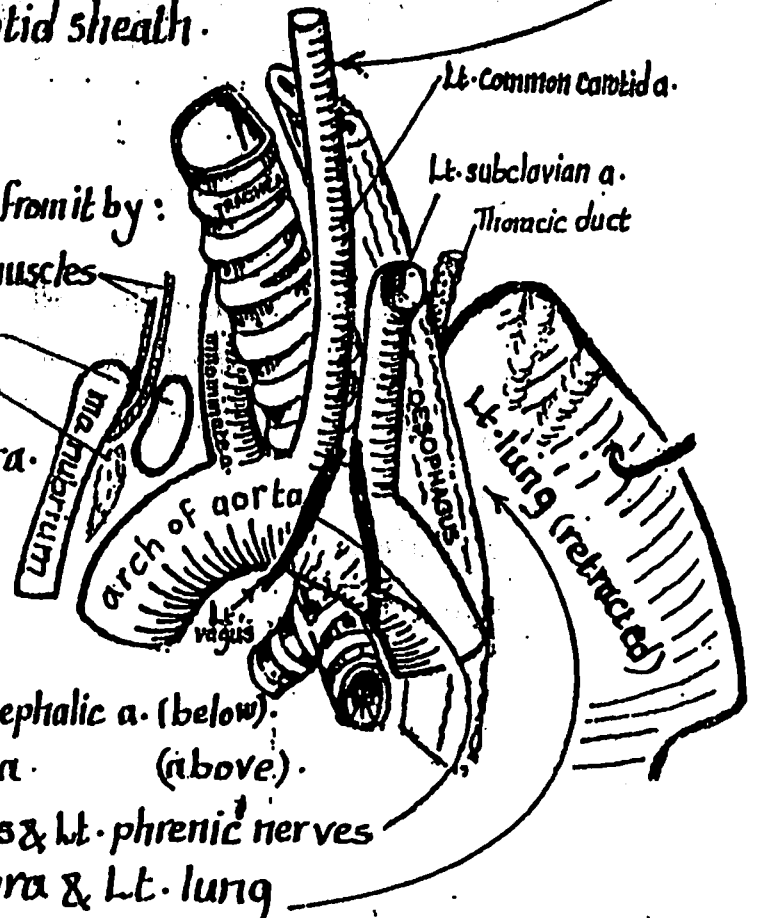
- (1) trachea ----- below.
- (2) Lt. subclavian a. above.

(C) On the Rt. side:

- (1) brachiocephalic a. (below).
- (2) trachea. (above).

(D) On the Lt. side:

- (1) Lt. vagus & Lt. phrenic nerves
- (2) Lt. pleura & Lt. lung



3- Lt. Subclavian a.

* Origin: from the arch of aorta 1 cm. behind the origin of Lt. Common Carotid a.

* Course: it ascends upwards & slightly laterally to enter the neck behind the Lt. sternoclavicular joint (being separated from it by the Lt. common carotid a.).

* Relations in the thorax:

(A) Anteriorly: it is separated from the manubrium by

Lt. margin of oesophagus.

(B) Posteriorly

thoracic duct.

Lt. lung & pleura (posterolateral).

(C) Rt. side: Trachea & oesophagus & Lt. recurrent laryngeal n. in between.

(D) Lt. side: Lt. pleura & Lt. lung.

- sternohyoid & sternothyroid
- ant. border of Lt. lung & pleura.
- Lt. brachiocephalic v.
- Lt. common carotid a.
- Lt. vagus & Lt. phrenic

Descending Thoracic Aorta

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- * Site: in posterior mediastinum.
- * Begins: as a continuation of aortic arch on the Lt. side of lower border of T₄ vertebra.
- * Ends: at the aortic opening of the diaphragm at lower border of T₁₂ vertebra by becoming abdominal aorta.

* Course:

It descends vertically downwards in the post. mediastinum lying at first to the Lt. side of bodies of 5th, 6th, 7th then it lies in front of the lower 5 Th. vertebrae (T₈ + T₁₂).

* Relations:

1] Posterior relations:

- a- Vertebral column
- b- Superior hemiazygos v. (as it crosses from Lt. to Rt. (T₈))
- c- Inferior hemiazygos v. (" " " " " " (T₉))

2] Anterior relations: (from above downwards)

- a- Lt. bronchus & root of Lt. lung
- b- Oblique sinus of pericardium (separating it from base of heart).
- c- Oesophagus (opposite T₈, 9, 10).
- d- Diaphragm (post. vertical part of it).

3] Lt. side:

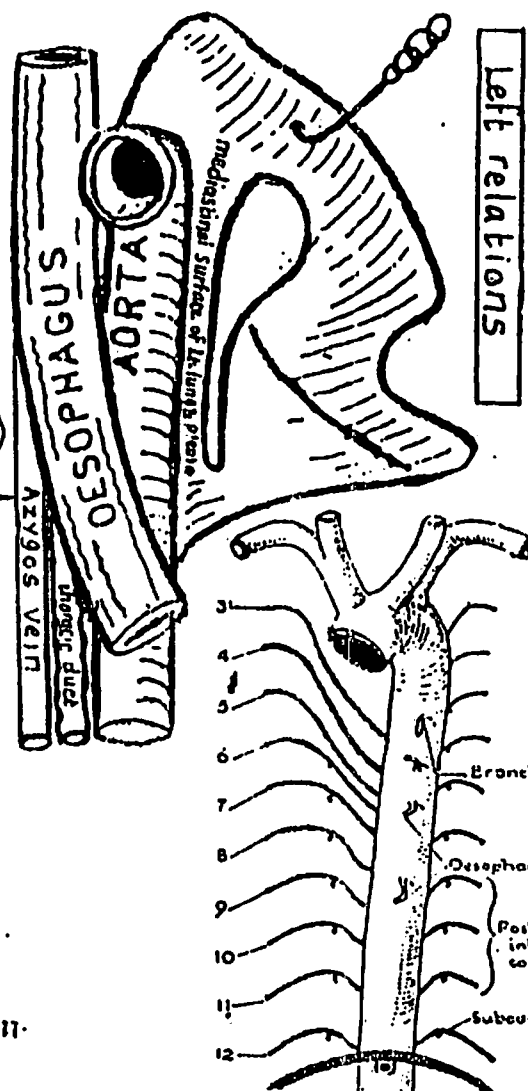
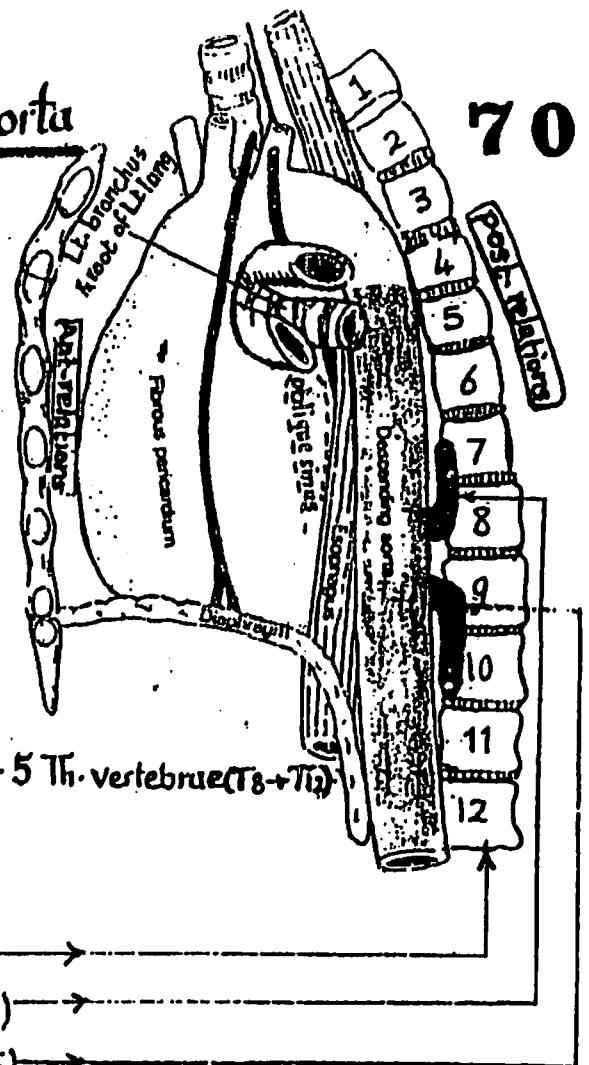
- a- Lt. lung & pleura
- b- oesophagus (below)

4] Rt. side:

- a- Oesophagus (above).
- b- Thoracic duct
- c- Azygos vein

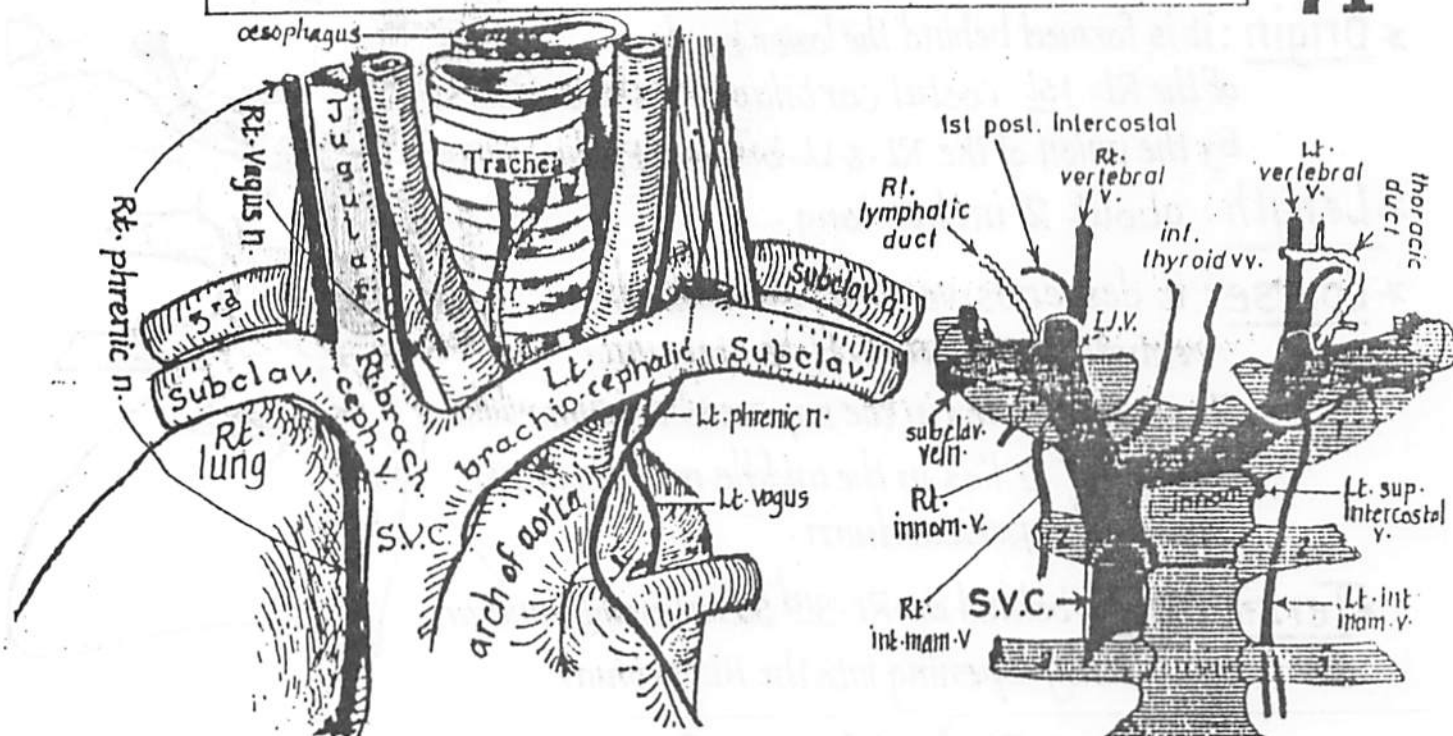
* Branches:

- 1- Post. intercostal aa. from 3rd downwards.
- 2- Subcostal arteries.
- 3- 2 Lt. bronchial arteries.
- 4- Oesophageal arteries (4 or 5).
- 5- Twigs to: Pericardium, mediastinum & diaphragm.



THE LARGE VEINS OF THE THORAX

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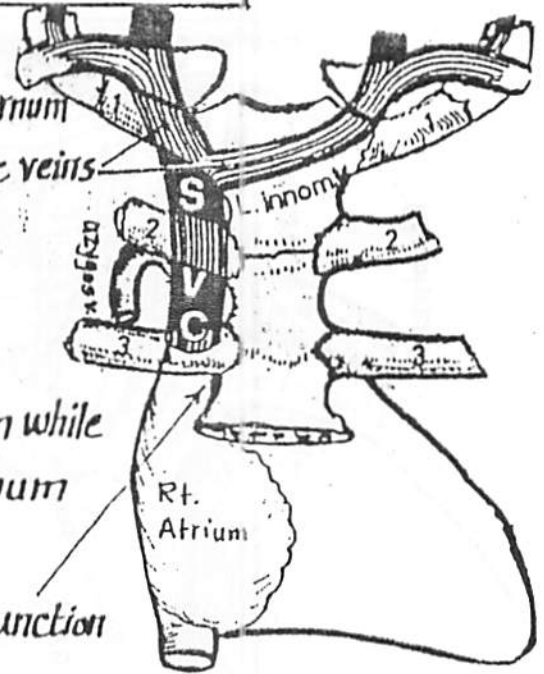
	Right Brachiocephalic vein	Left Brachiocephalic vein
Beginning	behind the med. end of the Rt. clavicle by union of Rt. internal jugular v. & the Rt. subclavian v.	behind the med. end of Lt. clavicle by union of Lt. internal jugular v. & the Lt. subclavian v.
Length	about one inch long.	about 3 inches long.
Course	it descends nearly vertically in the sup. mediastinum, along the right side of the brachiocephalic artery	it runs obliquely downwards & to the Rt. behind the upper $\frac{1}{2}$ of the manubrium sterni, along the upper convex aspect of the arch of aorta.
Relations	- Laterally: Rt. phrenic n., Rt. internal mammary a., Rt. pleura & lung. - posteromedially: it is related to the brachiocephalic a. & Rt. vagus n.	- Anteriorly: remains of thymus gland, sternohyoid & sternothyroid muscles & the manubrium sterni. - posteriorly: it crosses the 3 branches of the aortic arch & the trachea.
Termination	The 2 brachiocephalic veins unite behind the Rt. border of the sternum opposite the lower border of the 1st Rt. Costal cartilage to form the S.V.C.	
Tributaries	(1) Rt. vertebral v. } 2 veins from the neck (2) Rt. inf. thyroid v. } (3) Rt. int. mamm. v. } (4) Rt. 1st post. intercostal v. } 2 veins from the thorax (5) Rt. lymphatic duct.	(1) Lt. vertebral v. } 2 veins from neck (2) Lt. inf. thyroid v. } (3) Lt. int. mamm. v. } (4) Lt. 1st post. intercostal v. } 3 veins from the thorax (5) Lt. sup. intercostal v. } (6) Thoracic duct

* Origin : it is formed behind the lower border of the Rt. 1st costal cartilage close to sternum by the union of the Rt. & Lt. brachiocephalic veins.

* Length : about 2 inches long.

* Course : it descends vertically downwards behind the Rt. border of the sternum. Its upper $\frac{1}{2}$ lies in the sup. mediastinum while its lower $\frac{1}{2}$ lies in the middle mediastinum inside the pericardium.

* Termination : behind the Rt. 3rd sternocostal junction by opening into the Rt. atrium



* Relations of S.V.C

(A) Laterally :

- (1) Rt. phrenic n.
- (2) Rt. pleura & Rt. lung

(B) Medially

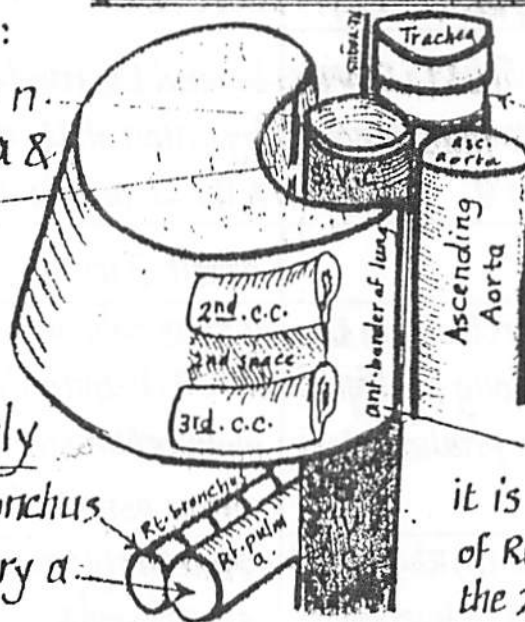
- (1) Trachea & Rt. vagus (posteromedial).
- (2) Ascending aorta (anteromedial).

(C) Posteriorly

- (1) Rt. main bronchus
- (2) Rt. pulmonary a.

(D) Anteriorly :

it is overlapped by the ant. border of Rt. pleura & lung separating it from the 2nd & 3rd costal cartilages & int. mam. a.

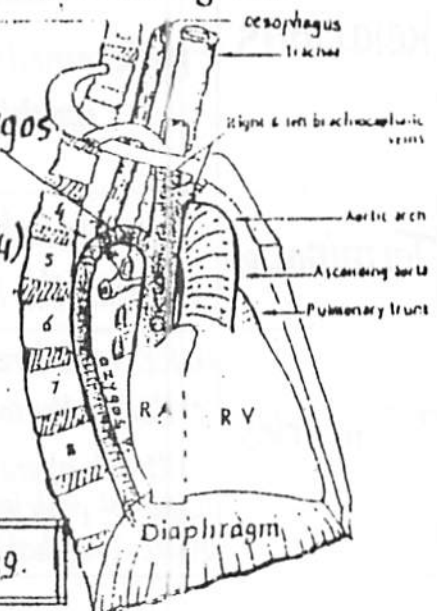


* Tributaries :

the S.V.C. has only one tributary : the arch of azygos vein which opens into the post. aspect of S.V.C. at the level of the 2nd costal cartilage (level of T₄)

* Field of Drainage of S.V.C. :

the S.V.C. drains the venous blood of the upper $\frac{1}{2}$ of the body.



The Inferior Vena Cava (I.V.C)

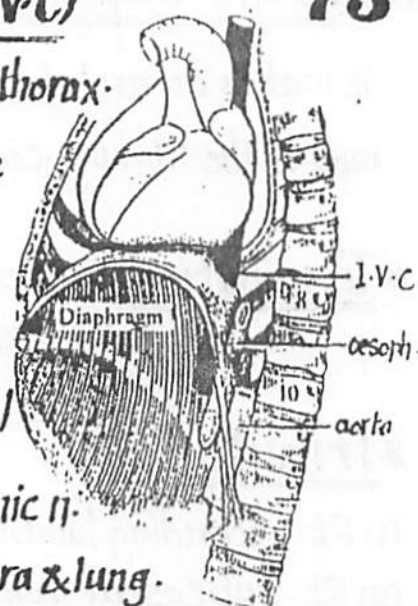
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* The uppermost part of the I.V.C ($\frac{1}{2}$ inch) lies in the thorax.

* it enters thorax by piercing the central tendon of the diaphragm opposite T8 vertebra.

* it ascends for $\frac{1}{2}$ an inch (inside the fibrous pericardium) to end by opening into the lower part of the Rt. atrium opposite the 6th Rt. sternocostal junction.

* along its course it is related laterally to



Azygos Vein

* It is a long vein which arises in the abdomen from the back of the I.V.C & ends in the thorax in the back of S.V.C

* Origin : variable :

- (1) most commonly : it arises in the abdomen from the back of the I.V.C at the level of the renal veins (opposite L2)
- (2) less commonly : it may begin between the diaphragm & the body of T12 as the continuation of the Rt. subcostal v.
- (3) occasionally : it arises by the union of the Rt. subcostal & Rt. ascending lumbar veins.

* Course & Relations :

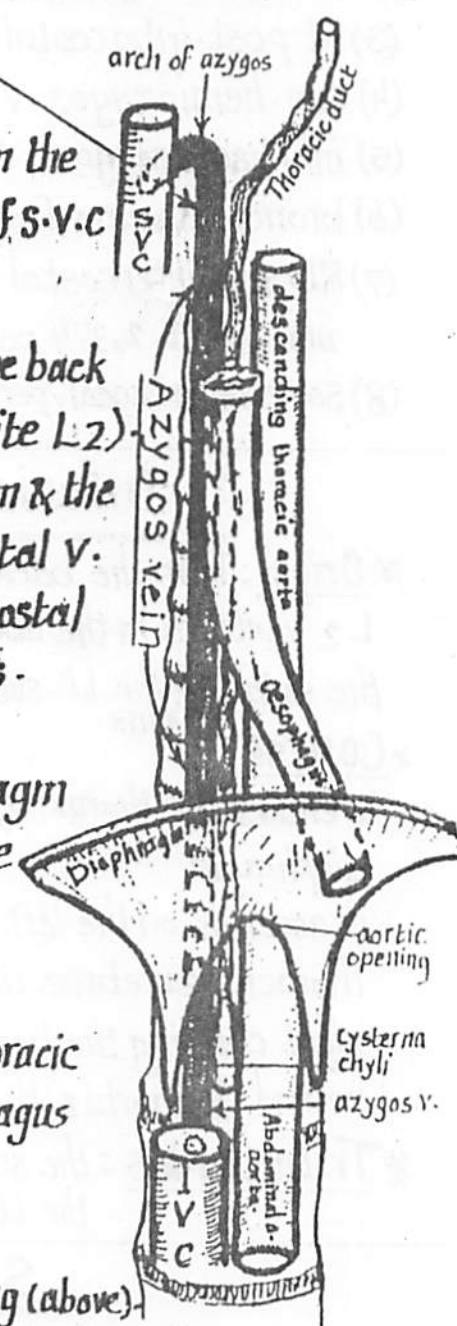
- it enters through the aortic opening of the diaphragm to ascend first in the post. mediastinum then in the sup. mediastinum.

(A) In the post. mediastinum :

- it ascends on the Rt. side of bodies of lower 8 thoracic vertebrae, lying behind the Rt. border of the oesophagus then behind the root of the Rt. lung.

- Relations :

- (1) Anteriorly : (a) oesophagus (below) (b) root of Rt. lung (above).
- (2) posteriorly : (a) lower 8 thoracic vertebrae (b) Rt. post. intercostal arteries.
- (3) to the left : (a) thoracic duct, (b) descending aorta.
- (4) to the right : Rt. lung & pleura.



(B) In the Sup. mediastinum (arch of azygos)

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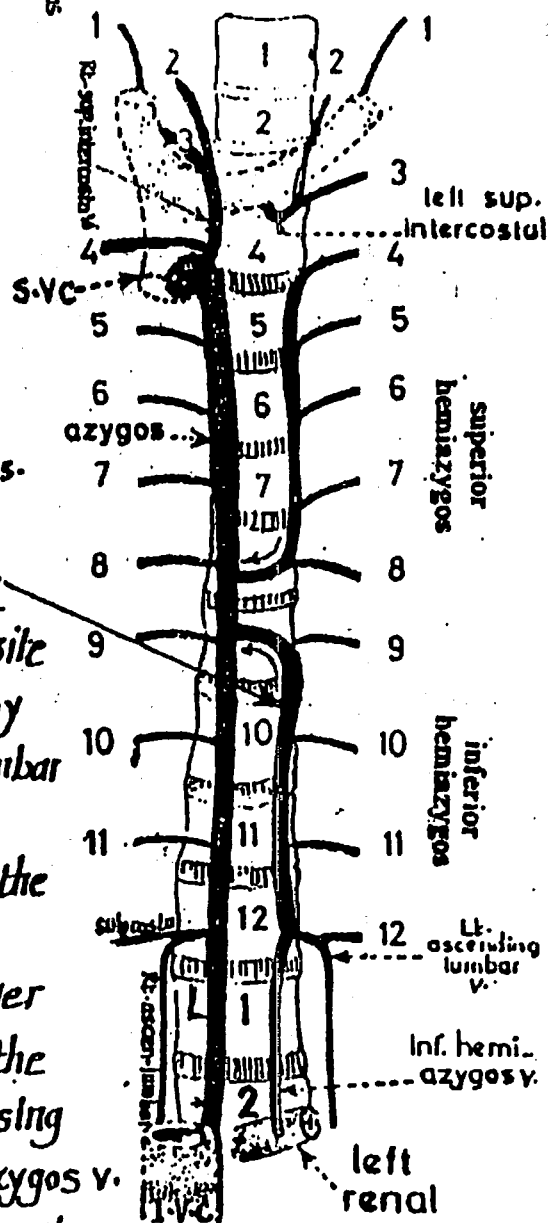
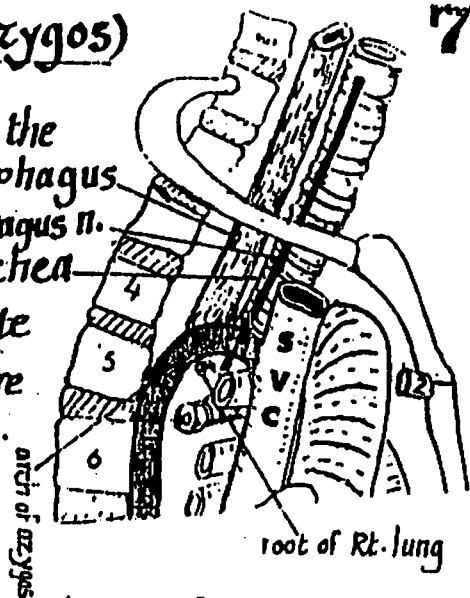
it makes an arch from behind forwards above the root of the Rt. lung crossing the sides of

oesophagus
Rt. vagus n.
trachea

* Termination: in the back of the S.V.C. opposite the 2nd Rt. costal cartilage (before the S.V.C. pierces the pericardium).

* Tributaries:

- (1) Rt. ascending lumbar vein.
- (2) Rt. subcostal vein.
- (3) Rt. post. intercostal veins from 5 to 11
- (4) sup. hemiazygos V. (opposite T8).
- (5) inf. hemiazygos V. (" T9).
- (6) bronchial veins from the Rt. lung
- (7) Rt. sup. intercostal v. (formed by the union of Rt. 2, 3, 4 post. intercostal veins).
- (8) Some oesophageal, pericardial & diaphragmatic veins.



Inferior Hemiazygos V.

* Origin: from the back of the Lt. renal v. opposite L2 vertebra in the abdomen or it may arise by the union of the Lt. subcostal & Lt. ascending lumbar veins.

* Course:

- it enters the thorax by piercing the Lt. crus of the diaphragm
- it ascends on the left side of the bodies of lower thoracic vertebrae till T9 where it bends to the right crossing the body of that vertebra (passing behind the aorta & thoracic duct) to end in the azygos v.

* Tributaries: the subcostal V. & the 11th, 10th, 9th post. intercostal veins of the Lt. side.

Superior hemiazygos Vein

* Origin: it begins at the post. end of the 5th Lt. intercostal space as a continuation of the 5th Lt. post. intercostal vein.

* Course: it descends on the left side of the bodies of the thoracic vertebrae down to T8 where it curves to the Rt. side crossing in front of T8 vertebra (behind the aorta & thoracic duct) to end in the azygos vein.

* Tributaries: 5th, 6th, 7th & 8th Lt. post. intercostal veins.

Collateral Venous anastomosis between S.V.C & I.V.C

* Sites:

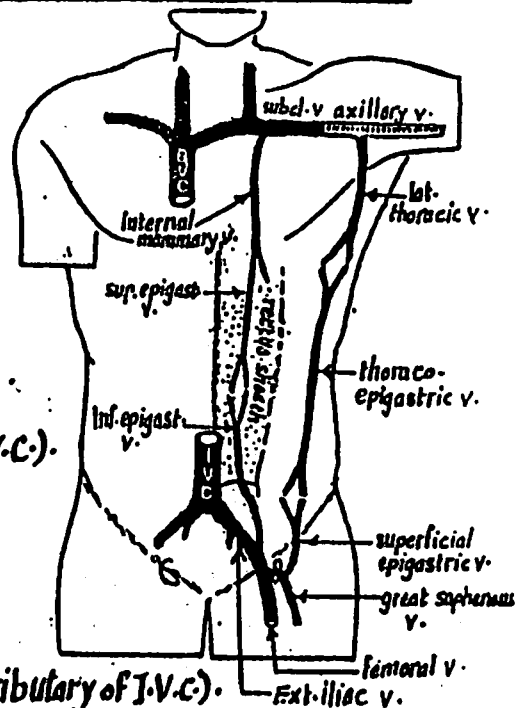
(A) In the ant. abdominal wall:

(1) the thoraco-epigastric v.: is a long vein running in the superficial fascia of the anterolateral wall of the trunk. It connects:

- (a) the lat. thoracic v. of axillary v. (drains into the S.V.C).
- (b) the superficial epigastric v. of femoral v. (drains into the I.V.C).

(2) the superior epigastric v. of internal mammary v.

(tributary of S.V.C) anastomoses inside the rectus sheath with the inf. epigastric v. of the Ext. iliac v. (tributary of I.V.C).



(B) In the posterior abdominal wall:

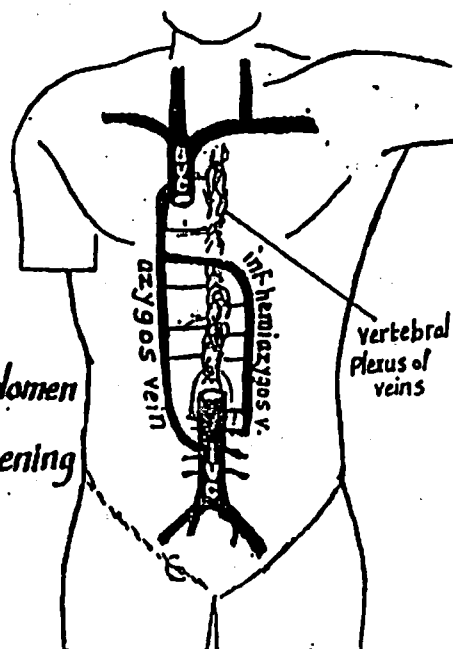
(1) the Azygos v.: arises from the back of the I.V.C in the abdomen & ends into the back of the S.V.C in the thorax (direct connection between S.V.C & I.V.C).

(2) the Inferior hemiazygos v.: is connected in the abdomen with tributaries of the I.V.C & ends in the thorax by opening into the azygos v. (tributary of the S.V.C).

(3) the vertebral plexus of veins: lies inside the

vertebral canal & around the vertebral bodies. It is connected with:

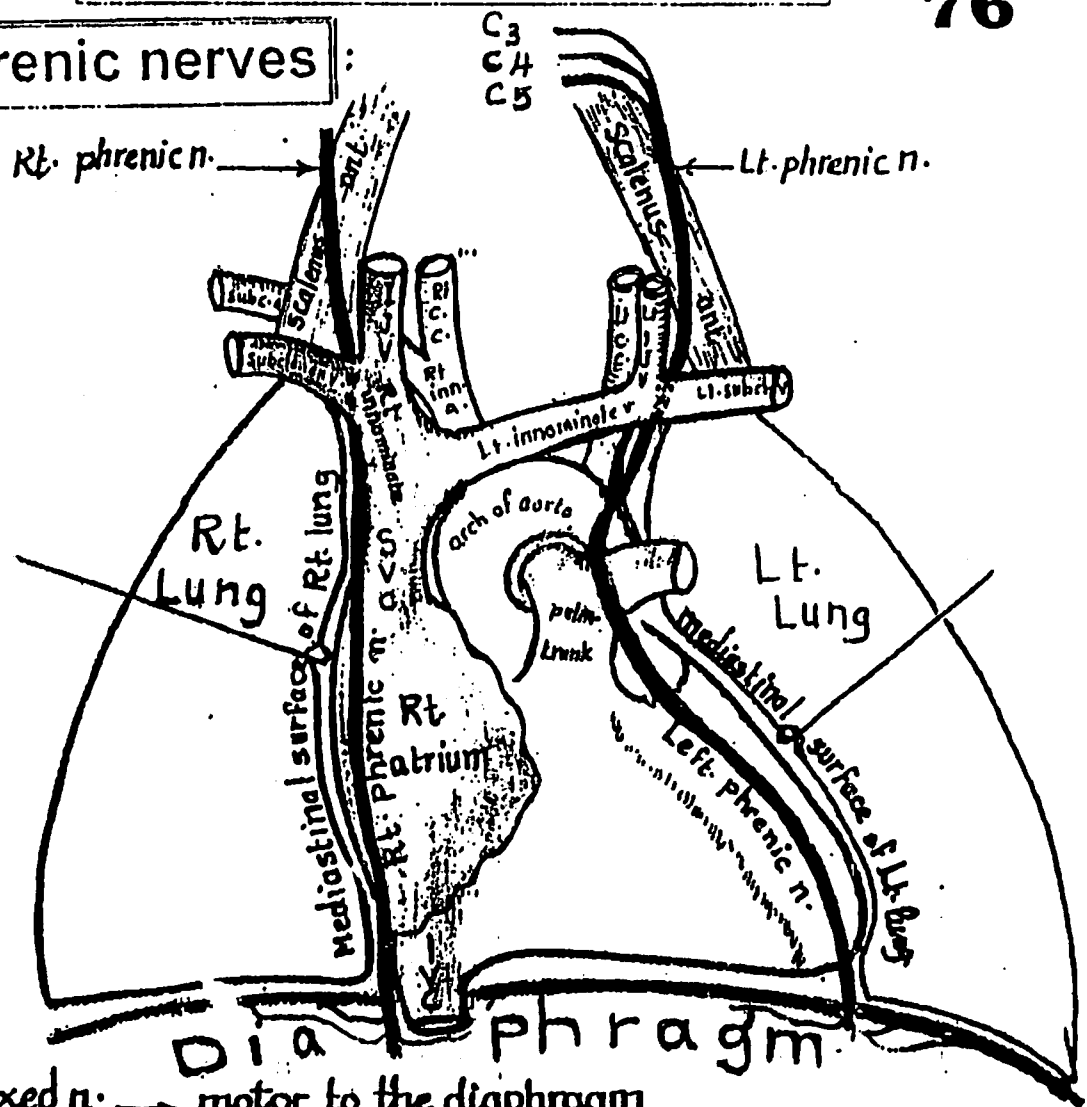
- (a) the lumbar veins (tributaries of I.V.C) in the abdomen.
- (b) the post. intercostal veins (tributaries of azygos & hemiazygos vv. of S.V.C) in the thorax.



Nerves of the thorax

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1-phrenic nerves :



- * Type:- Mixed n.
 - motor to the diaphragm
 - Sensory to the Serous membranes
 - (1) Pericardium
 - (2) Pleura covering diaphragm
 - (3) Peritoneum lining diaphragm
- * Origin:- In the neck from cervical plexus.
[ant. 17 rami of C₃, 4, 5 ; mainly C₄].

NB:- The root from C₅ may descend separately forming accessory phrenic nerve which joins the main phrenic at the level of 1st rib or the root of the lung.

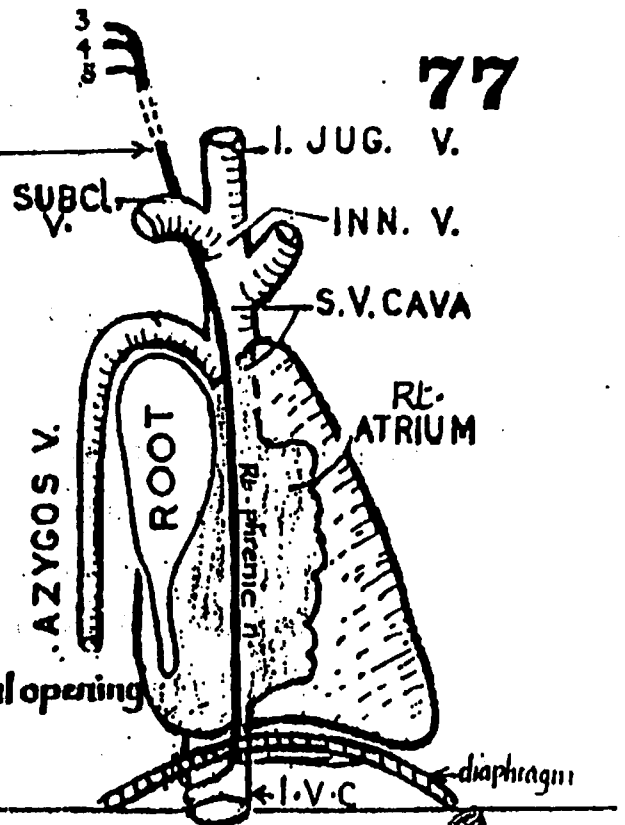
* Course & relations:

- A] In the neck: each phrenic n. descends on the scalenus anterior m. deep to the sternomastoid m.
- B] At the root of neck: each phrenic n. enters the thorax by passing deep to the beginning of innominate vein.
- C] In the Thorax: The phrenic nerves descend 1st in the sup-mediastinum, then in the middle mediastinum accompanied by pericardiophrenic vessels in front of root of lung.

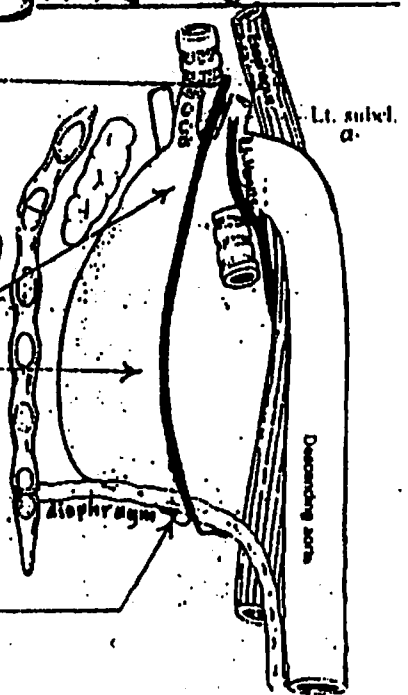
(1) The Rt. phrenic nerve:

Medially: It descends on the side of the great venous line i.e.:

- Rt. innominate v.
- S.V.C
- Pericardium covering Rt. atrium.
- Inferior vena cava.
- Laterally: It is related to the mediastinal surface of Rt. pleura & lung.
- * It leaves the thorax through the venacaval opening of the diaphragm.

(2) The Lt. phrenic nerve:

- Medially: It descends on the Lt. side of the following arterial structures:
 - Lt. common carotid a. (between it & Lt. subclavian a.)
 - Arch of aorta
 - The pericardium covering the Lt. Ventricle
- Laterally: It is related to the mediastinal surface of Lt. pleura & lung.
- * It leaves the thorax through a special opening in the Lt. cupola of diaphragm

* Distribution of phrenic nerve:

- 1) Motor: to the diaphragm (It is the only motor nerve which supplies diaphragm)
- 2) Sensory: to
 - 1] Pericardium.
 - 2] Pleura (mediastinal & diaphragmatic).
 - 3] Peritoneum lining the abd. surface of the diaphragm.
 - 4] Rt. phrenic. also supplies Gall Bladder.

N.B: ① Each phrenic n. supplies the diaphragm from its abdominal surface.

② Although diaphragm is an abdominal organ its n. supply is derived from the neck because embryologically it is derived from septum transversum which lies in the neck then migrates downwards.

③ Rt. phrenic n. is shorter than Lt. phrenic because :: a] Rt. cupola of the diaphragm is higher than the left b] The Rt. side of pericardium is straight

2- Vagus Nerve

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- * Type :- mixed n.
- Parasympathetic
 - motor
 - Sensory

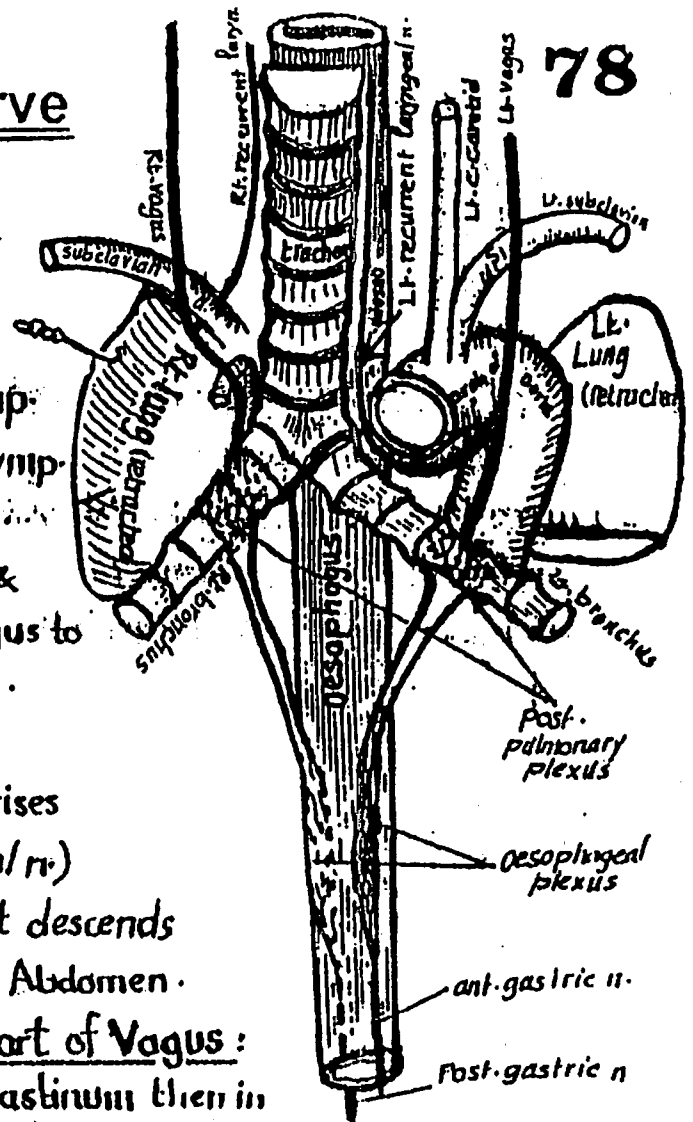
It is the most important parasymp. n. in the body as it supplies parasymp. fibres to :-

- a] The Respiratory tube
- b] The Digestive tube & glands from oesophagus to the Lt. colic flexure.
- c] The heart (atria).

- * Origin:- It is the 10th cranial n. & arises from the medulla (the longest cranial n.)
It is called vagus (vague) because it descends from Head to Neck to Thorax to Abdomen.

- * Course & Relations of the thoracic part of Vagus :

The vagi descend first in the sup. mediastinum then in the post. mediastinum having the following course & relations:



Course	Right Vagus	Left Vagus
1] At the Root of Neck	It enters thorax by crossing in front of 1st part of subclavian a.	It enters thorax by passing between Lt. C. Carotid & Lt. subclavian aa.
2] In the Sup. mediastinum (Above Root of lung)	<p>* It descends behind Rt. Innominate vein to reach the back of Rt. bronchus</p> <p><u>Medially</u>: related to Trachea</p> <p><u>Laterally</u>: " " Arch of Azygos, Rt. lung & Rt. pleura.</p>	<p>* It descends on the left side of Aortic arch to reach back of Lt. bronchus</p> <p><u>Medially</u>: related to Arch of Aorta.</p> <p><u>Laterally</u>: " " Lt. pleura & lung & crossed by Lt. phrenic nerve.</p>
3] Behind Root of Lung	It breaks behind the Rt. bronchus into filaments forming post. pulmonary plexus	It breaks behind the Lt. bronchus into filaments forming post. pulmonary plexus
4] Below Root of Lung	From the lower end of posterior pulmonary plexus, 2 or 3 filaments descend to the back of Oesophagus sharing in oesophageal plexus.	From the lower end of post. pulmonary plexus, 2 or 3 filaments descend to the front of the oesophagus to share in the formation of oesophageal plexus.

	Right Vagus	Left Vagus
5] Near the diaphragm	The Rt. vagus n. is formed again from the lower end of the oesophageal plexus & descends to the abdomen through the oesophageal opening of the diaphragm forming the Post. Gastric nerve.	The Lt. vagus is formed again from the lower end of the oesophageal plexus & descends to the abdomen through the oesophageal opening of diaphragm forming the Ant. Gastric nerve.

* Branches of the Vagi in the thorax :-

- 1] Cardiac branches :- arise from the vagi in the Superior mediastinum & carry parasympathetic fibres to cardiac plexuses (see page 64)
- 2] Left recurrent Laryngeal n. :- arises from the Lt. vagus in the sup. mediastinum as it crosses the arch of aorta. It then curves below the arch & ascends behind the ligamentum arteriosum to continue upwards in the groove between the trachea & oesophagus.
N.B :- The Rt. recurrent laryn. n. arises from the Rt. vagus in the root of neck & curves around the 1st part of Rt. subclavian a.
- 3] Post. pulmonary branches :- Large & numerous which form the main part of the post. pulm. plexus (providing parasymp. fibres to the plexus).
- 4] Ant. pulmonary branches :- 2 or 3 filaments which share in the anterior pulmonary plexus.
- 5] Oesophageal branches :- which form the main part of the oesophageal plexus which supplies the oesophagus & sends filaments to the back of pericardium.

* Applied Anatomy :-

- Injury of vagus nerve is uncommon, but if it happens, it usually occurs during its intracranial course or due to damage of its nuclei in medulla.
- Lt. recurrent laryn. n. is related to tracheo-bronchial L.Ns, so enlargement of these L.Ns causes irritation of the nerve causing persistent cough & alteration of voice because Lt. vocal cord is affected. This is seen in cases of lung cancer.

3- Thoracic part of the Sympathetic chain 80

* Entrance into thorax:

each sympathetic chain enters the thorax by crossing in front of the neck of the first rib

* Course & relations:

- the 2 sympathetic chains descend paravertebrally (i.e. on each side of the vertebral column) first in the sup. mediastinum then in the post. mediastinum.
- in the upper part of the thorax: the symp. chains descend in front of the necks of the ribs.
- in the lower part of the thorax they descend on the sides of the bodies of the thoracic vertebrae.
- Each symp. chain is covered by the parietal pleura (costal pleura) throughout its whole course in the thorax.

* Exit From the thorax:

each symp. chain leaves the thorax by passing behind the med. arcuate lig. of diaphragm to enter the abdomen.

* Ganglia of the symp. chain:

the thoracic part of each symp. chain carries 11 or 12 ganglia. The 1st thoracic ganglion may unite with the inf. cervical ganglion forming the stellate ganglion.

* Branches:

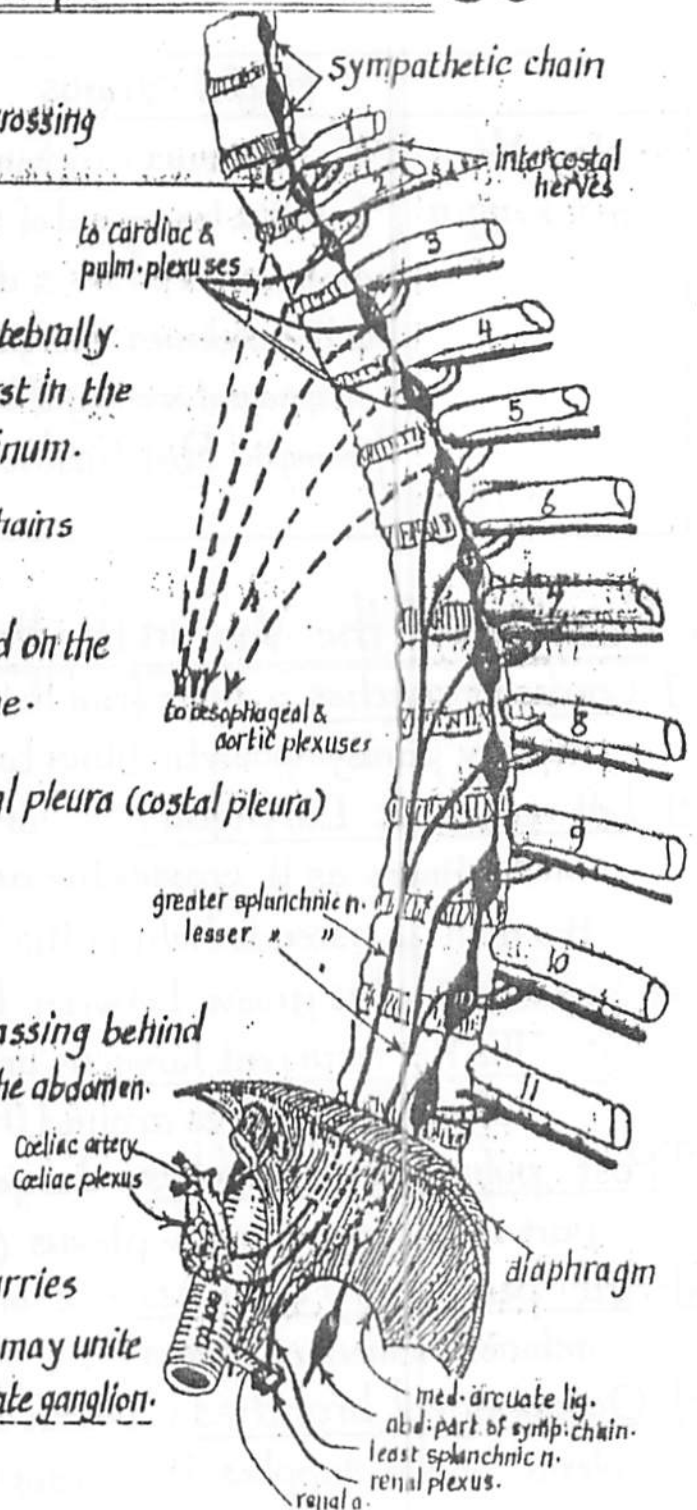
(A) Lateral (communicating) branches to the spinal nerves: each ganglion is connected to the corresponding spinal n. by 2 rami communicans:

(1) white ramus communicans: carrying preganglionic symp. fibres from the spinal n. to the ganglion.

(2) grey ramus comm.: carries post-ganglionic symp. fibres from the ganglion to the spinal n.

(B) Medial visceral branches:

(1) branches from the upper 5 ganglia carry postganglionic symp. fibres to the aortic & oesophageal plexuses.



(2) Branches from the 2nd, 3rd & 4th ganglia carry postganglionic symp. fibres to the cardiac & pulmonary plexuses

(3) Greater splanchnic n.: arises from the 5th, 6th, 7th & 8th ganglia:

- it carries preganglionic efferent & visceral sensory afferent fibres.
- it runs obliquely on the vertebral bodies downwards under cover of pleura.
- it leaves the thorax by piercing the corresponding crus of diaphragm.
- it ends in the abdomen by joining the coeliac & aorticorenal ganglia.

(2) Lesser splanchnic n.: arises from the 9th & 10th ganglia:

runs the same course as the greater splanchnic n. to end in the coeliac plexus.

(3) Least (lowest) splanchnic n. arising from the 12th ganglion

it may accompany the symp. chain or may pierce the corresponding crus to end in the renal plexus around the renal a.

Autonomic plexuses in the thorax

(1) Cardiac plexus:s (superficial & deep): see page 62.

(2) pulmonary plexuses: (ant. & post):

- site: they lie in front & behind the roots of the lungs (Rt. & Lt.).

- formation:

the post. pulmonary plexus	the anterior pulmonary plexus
- formed behind the bronchus by: (a) <u>parasymp.</u> fibres from the vagus n. (b) <u>symp.</u> fibres from the 2nd, 3rd & 4th thoracic sympathetic ganglia. - it is larger than the ant. pulm. plexus.	formed in front of the bronchus by (a) filaments from the post. pulm. plexus.. (b) filaments from the deep cardiac plexus. <u>N.B:</u> the Lt. plexus receives fibres from the superficial cardiac plexus also.

- functions:

(a) the parasymp. fibres are concerned with the respiratory reflexes

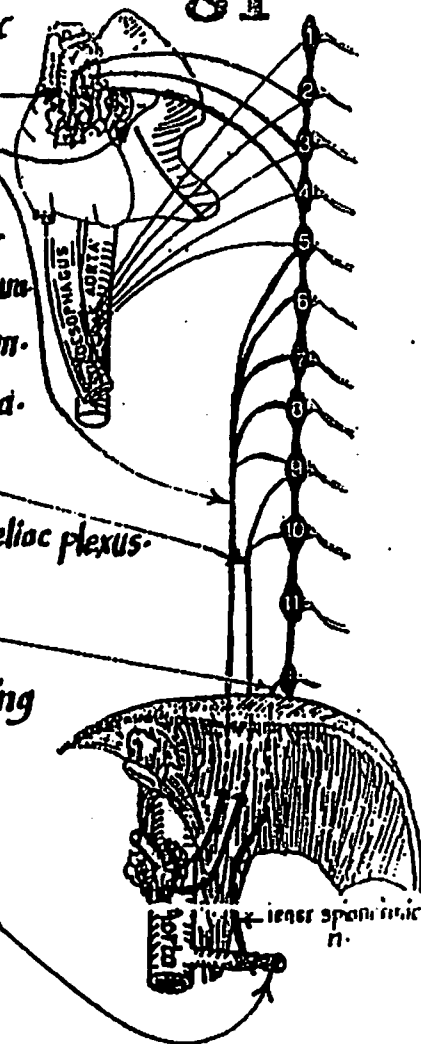
(b) the symp. fibres are: bronchodilator, vasoconstrictor & sensory to the bronchial tree & vis. pleura.

(3) oesophageal plexus: lies around the oesophagus & is formed of:

(a) parasymp. fibres from the 2 vagi (b) symp. fibres from the upper 5 thoracic ganglia.

- it supplies autonomic fibres to the oesophagus.

(4) Aortic plexus: formed by symp. fibres mainly (from the upper 5 th. ganglia) & lies around the aorta.



1- Trachea

it is an elastic tube which conveys air into & out of the lungs.

Length : 4-4.5 inches (10-12 cm).

Diameter : internal diameter : 1.2 cm.
external " : 2 cm.

* Beginning : in the neck at the lower end of the larynx
(at the lower border of cricoid cartilage of larynx opposite C6).

* Termination : in the thorax at the level of the sternal angle
(opposite lower border of T₄) by dividing into the Rt. & Lt. bronchi.

* Course : it descends vertically in the middle line except at its lower end where it is pushed slightly to the right by the aortic arch
- its upper 1/2 (cervical part) : lies in the lower part of neck.
- its lower 1/2 (thoracic part) : lies in the sup. mediastinum of thorax.

* Structure :

the walls of the trachea is supported by 16-20 cartilagenous rings
the tracheal rings are C-shaped, being deficient posteriorly where they are replaced by smooth m. fibres (trachialis m.) to allow distension of the oesophagus.

* Constrictions of the trachea :

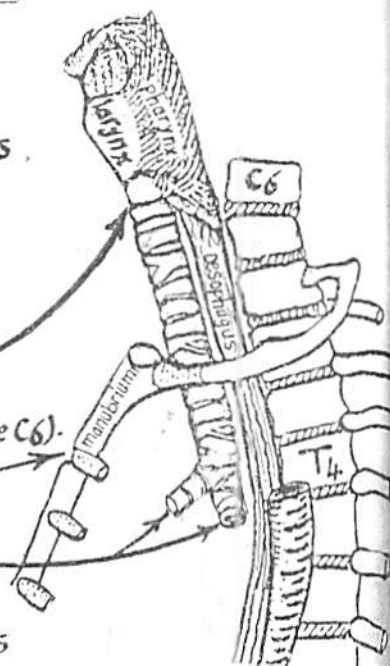
the trachea shows 3 normal constrictions :

- (1) at its upper end : it may be constricted by the thyroid gland.
- (2) at its middle : it is constricted on the Rt. side by the innominate a.
- (3) at its lower end : it is constricted on the Lt. side by the arch of aorta.

* Surface anatomy : a band 2 cm. wide extending from the cricoid cartilage to the lower border of manubrium sterni.

* Relations of the trachea

(1) relations of the cervical part : see head & neck (page 164).

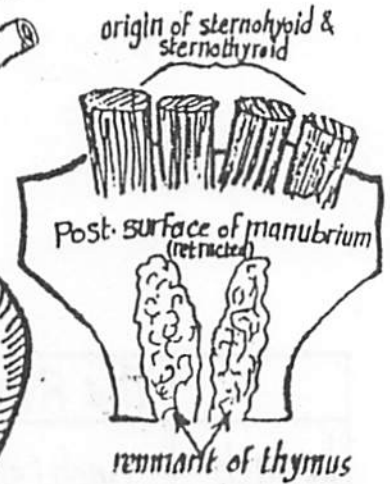
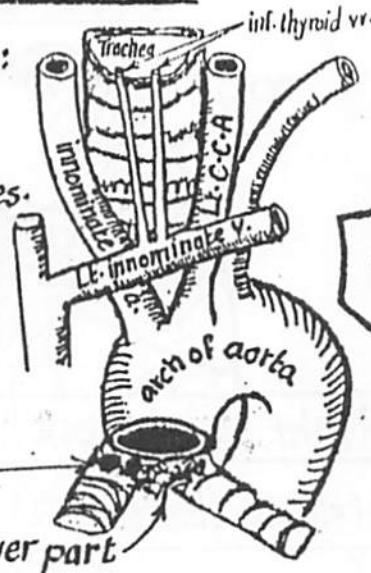


(2) Relations of the thoracic part

83

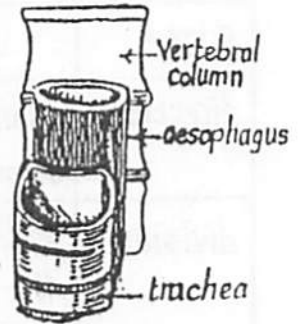
I- Ant-relations (from before backwards):

- (1) manubrium sterni
- (2) origin of sternohyoid & sternothyroid muscles.
- (3) remnant of thymus gland.
- (4) Lt. innominate v. & inf. thyroid veins.
- (5) arch of aorta & origin of the innominate & the Lt. Common carotid arteries.
- (6) pre tracheal lymph nodes
- (7) the deep cardiac plexus (in front of its lower part)



II- Posterior relations:

the oesophagus is a direct post. relation separating the trachea from the vertebral column.

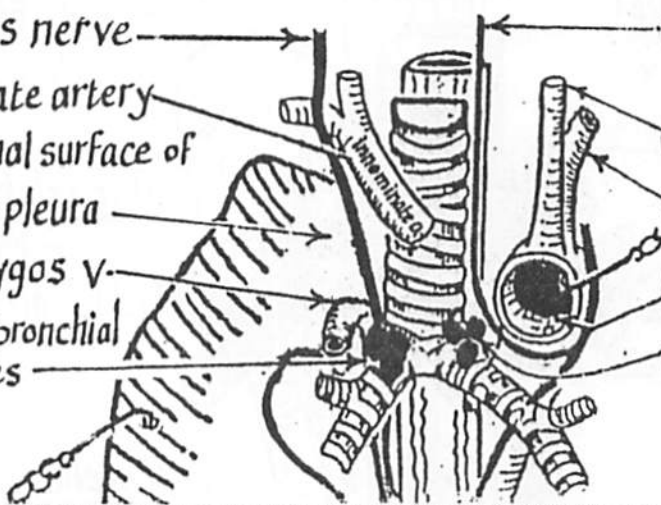


III- Right relations

- (1) Rt. vagus nerve
- (2) innominate artery
- (3) mediastinal surface of Rt. lung & pleura
- (4) arch of azygos v.
- (5) Rt. tracheobronchial lymph nodes

IV- Left relations

- (1) Lt. rec. laryngeal n. (in the Lt. groove between trachea & oesoph.).
- (2) Lt. common carotid artery.
- (3) Lt. subclavian artery.
- (4) arch of aorta
- (5) Lt. tracheo-bronchial L.Ns.



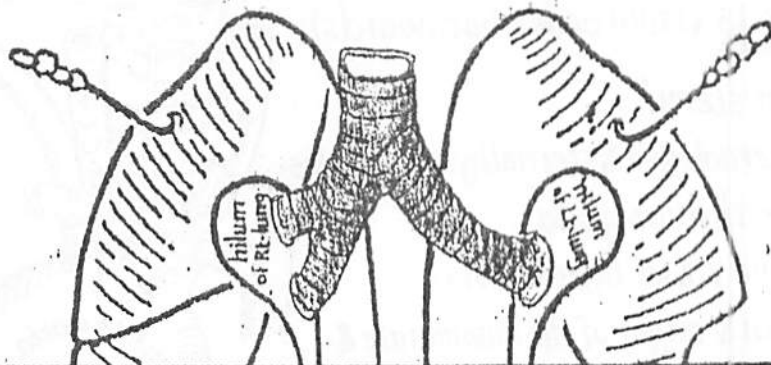
* Blood Supply of the trachea

Part	Arterial supply	venous drainage
Cervical part	inferior thyroid arteries.	inferior thyroid veins.
thoracic part	bronchial arteries: supply the thoracic part + the bronchial tree. - the Rt. bronchial a. arises from the 3rd Rt. post. intercostal a. - the 2 Lt. bronchial aa. arise from descending thoracic aorta.	bronchial veins: * Rt. bronchial vv. drain into azygos v. * Lt. bronchial vv. drain into hemiazygos veins.

* Nerve supply: autonomic fibres from the 2 vagi & the 2 sympathetic chains.

The Bronchi

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	The Right main bronchus	The Left main bronchus
Length	1 inch (shorter than the left)	2 inches (longer than the right)
Size	wider	narrower
direction	more vertical (lies in line with the trachea) forming an angle of 25° with middle line.	more horizontal (forming an angle of 45° with the middle line).
division	it divides before entering the hilum of the Rt. lung (1" from its origin) into: eparterial bronchus & hyparterial bronchus	it divides at the hilum or inside the left lung (2" from its origin) into 2 secondary bronchi
Relations	<p><u>superior relations:</u> arch of azygos V.</p> <p><u>Ant. relations:</u> (1) Rt. pulmonary a. (2) S.V.C & base of heart. (3) ascending aorta</p> <p><u>Post. relations:</u> (1) azygos vein. (2) oesophagus. (3) Rt. bronchial vessels. (4) Rt. post. pulmonary plexus.</p>	<p><u>superior relations:</u> arch of aorta.</p> <p><u>Ant. relations:</u> (1) Lt. pulmonary a. (2) Lt. atrium</p> <p><u>Post. relations:</u> (1) descending aorta. (2) oesophagus. (3) Lt. bronchial vessels. (4) Lt. post. pulmonary plexus.</p>
Arterial supply	one Rt. bronchial artery arising from the 3rd Rt. post. intercostal a.	2 Lt. bronchial arteries arising from the descending thoracic aorta.
Venous drainage	into the azygos vein.	into sup. & inf. hemiazygos veins
N. supply	From the anterior & posterior pulmonary plexuses (page 78).	

CLINICALLY IMPORTANT POINTS RELATED TO TRACHEA & BRONCHI : see page 99 .

2- Oesophagus

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* It is one of the narrowest & most muscular parts of the digestive tube. Its lumen opens only during deglutition.

* Length: 25 cm. (10 inches).

* Beginning: in the neck, at the lower border of C6 (the lower border of cricoid cartilage) as a downward continuation of the pharynx.

* Termination: in the abdomen, immediately below the the oesophageal opening of the diaphragm (opposite the lower end of T10, 1 inch to the left of middle line) by joining the cardiac end of the stomach.

* Parts:

(1) cervical part: the upper 5 cm. (in the lower part of neck).

(2) thoracic): the longest part, descending first in the sup. mediastinum then in the post. mediastinum.

(3) abdominal): the shortest part (1.5") which lies below the diaphragm.

* Course: it descends in the middle line (following the vertebral column except at 2 sites where it deviates to the left:

(1) at the inlet of the thorax.

(2) near its lower end (opposite T8, 9, 10) where it deviates gradually to the left to reach the oesophageal opening of diaphragm which lies 1" to the left of the middle line.

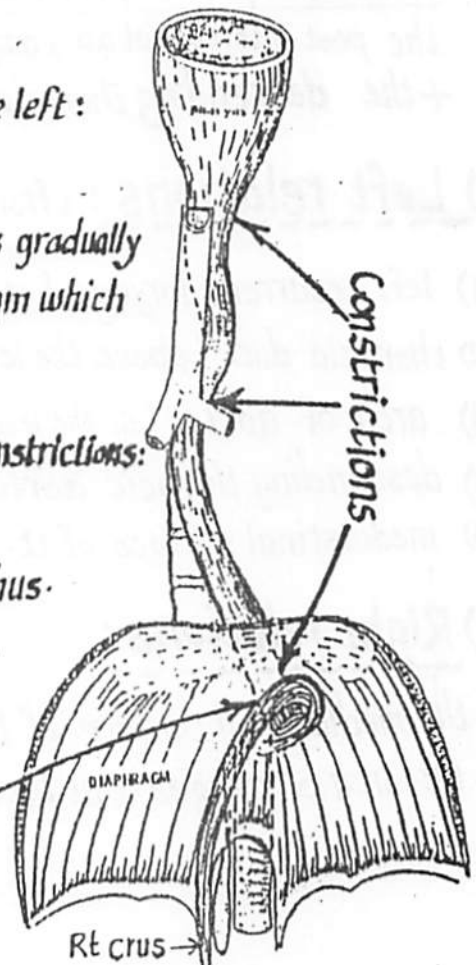
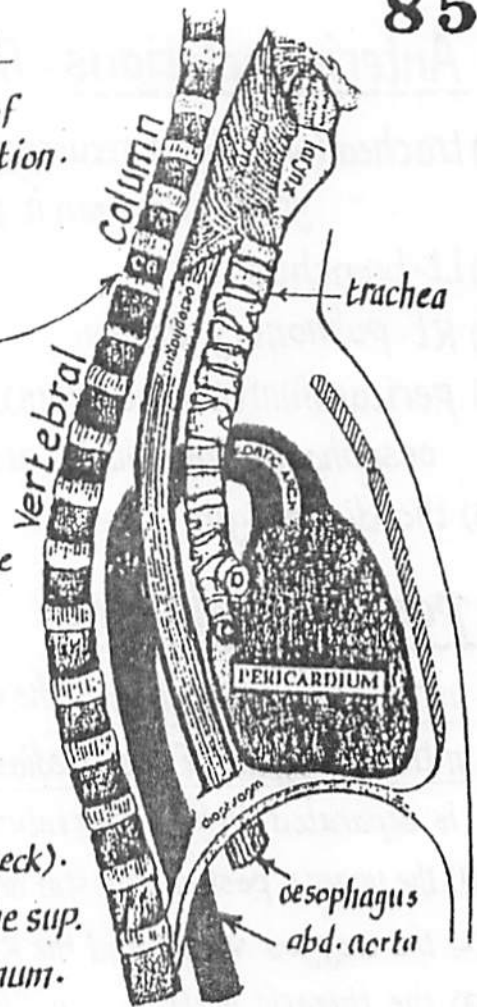
* Constrictions: normally the oesophagus shows 3 constrictions:

(1) at its beginning in the neck.

(2) at the site where it is crossed by the Lt. main bronchus.

(3) at its lower end as it passes through the diaphragm.

* Sphincters: the lower end of the oesophagus has no anatomical sphincter. The **Oesophageal bundle** of the Rt. crus of the diaphragm acts as a physiological sphincter.

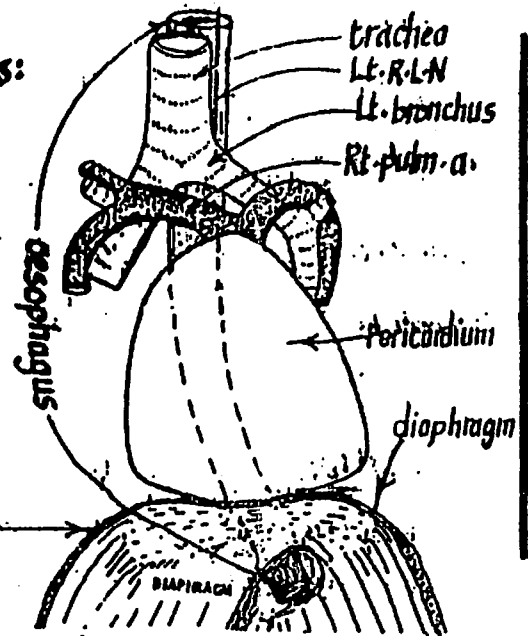


* Relations of the oesophagus in the thorax

86

(A) Anterior relations: from above downwards:

- (1) trachea (with the Lt. recurrent laryngeal n. in the Lt. groove between it & the oesophagus).
- (2) Lt. bronchus.
- (3) Rt. pulmonary artery.
- (4) pericardium (oblique sinus) separating the oesophagus from the Lt. atrium of the heart.
- (5) the diaphragm.



Anterior relations.

(B) Posterior relations:

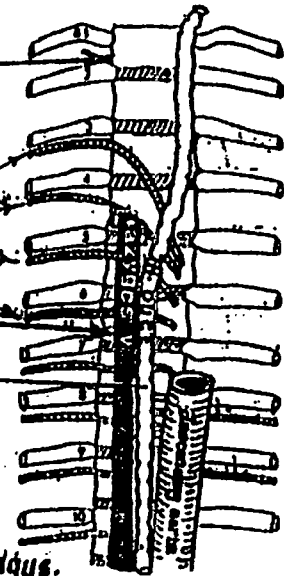
I- in the sup. mediastinum: the vertebral column.

II- in the upper part of post. mediastinum: the oesophagus is separated from the vertebral column by:

- (1) the upper 5 post. intercostal arteries of the Rt. side
- (2) the azygos v. (behind the Rt. border of the oesophagus)
- (3) the thoracic duct (" " " " " ")

III- in the lower part of post. mediastinum (opposite T₈, 9, 10)

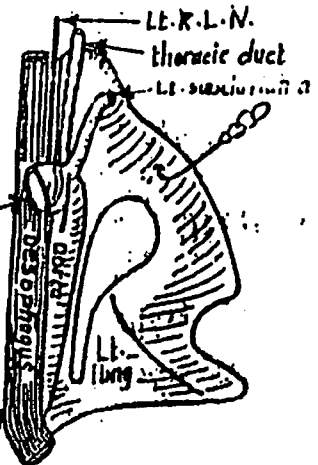
the post. intercostal aa., azygos v., thoracic duct + the descending thoracic aorta lie behind the oesophagus.



posterior relations

(C) Left relations: (from above downwards):

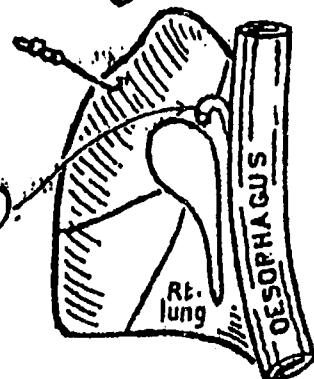
- (1) left recurrent laryngeal n.
- (2) thoracic duct (above the level of T₈).
- (3) arch of aorta (at the level of T₃/T₄)
- (4) descending thoracic aorta.
- (5) mediastinal surface of Lt. lung & pleura (just above diaphragm)



Left relations

(D) Right relations:

- (1) the mediastinal surface of the Rt. lung.
- (2) the arch of azygos (at the level of lower border of T₄).



Right relations

* Blood Supply of oesophagus:

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(A) the cervical part:

- arterial supply: by inf. thyroid arteries
- Venous drainage: " " " " veins into innominate veins.

(B) the thoracic part:

- arterial supply: by oesophageal branches of
 - (1) descending thoracic aorta
 - (2) bronchial arteries
- Venous drainage: into azygos & hemiazygos veins.

(C) the abdominal part:

- arterial supply: (1) inf. phrenic branches of abd. aorta
(2) oesophageal br. of left gastric a.
- Venous drainage: into left gastric v. (tributary of portal v.).

N.B: the lower end of the oesophagus is one of the sites of the portosystemic anastomoses.

* Lymphatic drainage:

(A) the cervical part: drains into the deep cervical lymph nodes.

(B) the thoracic part: drains into the bronchial L.Ns & preaortic group of post-mediastinal L.Ns.

(C) the abdominal part: drains into the paracardiac group of Lt. gastric L.Ns.

* Nerve Supply of the oesophagus:

the oesophagus is richly supplied by autonomic nerves which form a rich oesophageal plexus.

(A) the cervical part receives:

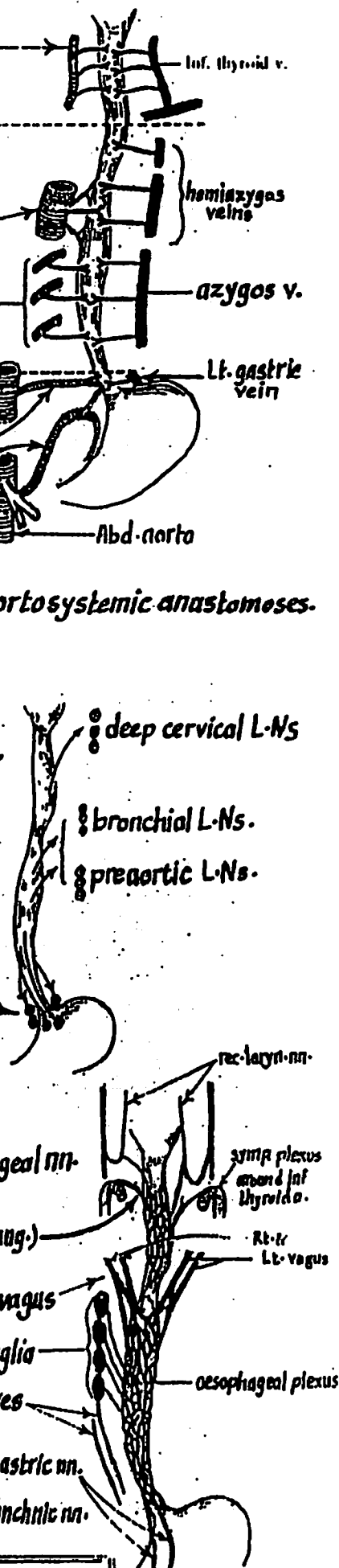
- parasymp. fibres from recurrent laryngeal nn.
- symp. fibres from plexus around the inf. thyroid a. (from middle cervical gang.)

(B) the thoracic part receives:

- Parasymp. fibres: from the Rt & Lt vagus
- symp. fibres from: (a) upper 4 th. ganglia
- (b) splanchnic nerves

(C) the abdominal part receives:

- parasymp. fibres from ant. & post. gastric nn.
- symp. fibres: from symp. chain & splanchnic nn.



CLINICALLY IMPORTANT POINTS RELATED TO OESOPHAGUS

: see page 99.

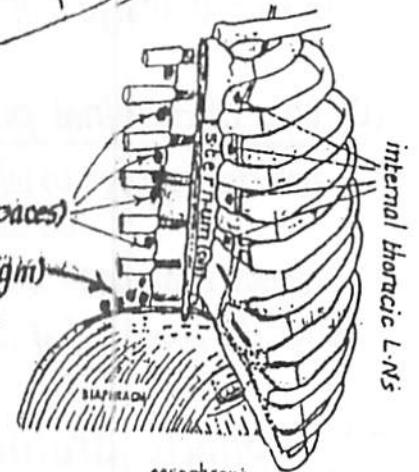
I- Lymphatic drainage of the thoracic wall:

(A) The superficial structures are drained by:

- (1) the deep cervical lymph nodes
- (2) the pectoral group of axillary lymph nodes
- (3) the scapular group " " " "
- (4) the internal thoracic L.Ns. (along the internal thoracic vessels)

(B) the deeper structures are drained by:

- (1) the internal thoracic L.Ns
- (2) the intercostal L.Ns (in the post. parts of the intercostal spaces)
- (3) the diaphragmatic L.Ns (related to upper surface of diaphragm)

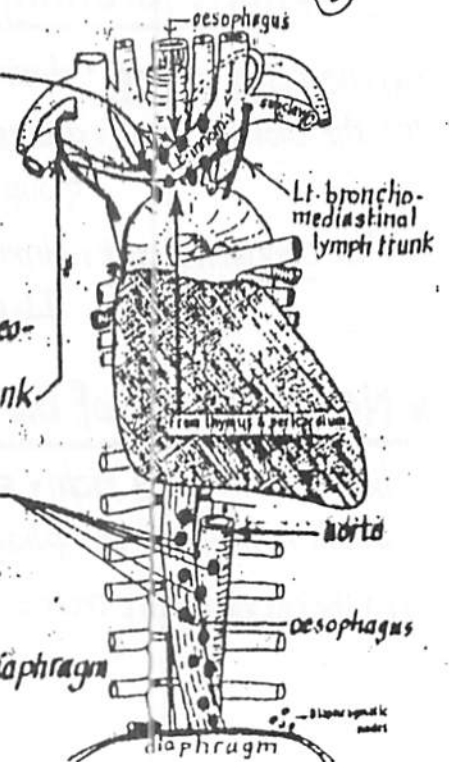


II- Lymphatic drainage of the thoracic contents:

the thoracic contents drain into 3 groups of L.Ns:

(1) Ant. mediastinal (tracheo-cephalic) group:

- lies in the sup. mediastinum along the Lt. innominate V.
- it receives afferent lymphatics from the thymus gland, the heart, & pericardium and the oesophagus.
- it sends efferent lymphatics to join those of the tracheo-bronchial group to form the broncho-mediastinal lymph trunk

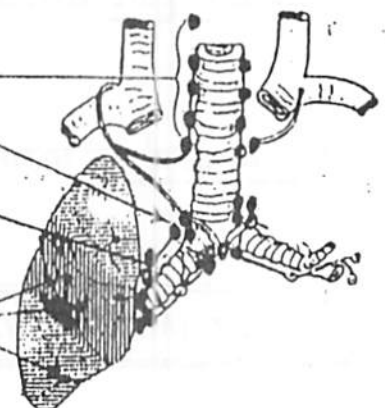


(2) Post. mediastinal group of L.Ns:

- it lies in the post. mediastinum in relation to the aorta & the oesophagus.
- it receives afferent lymphatics from the pericardium, diaphragm, oesophagus & the upper surface of the liver.

(3) Tracheo-bronchial L.Ns: include 4 groups:

- (a) paratracheal L.Ns: along the sides of the trachea
- (b) tracheo-bronchial L.Ns: at the tracheal bifurcation
- (c) broncho-pulmonary L.Ns: at the hila of the lungs
- (d) pulmonary L.Ns: inside the lungs along the major branches of the bronchial tree.



* The tracheobronchial L.Ns receive afferent lymphatics from the trachea, heart, lungs & the bronchi. **89**

* They send efferent lymphatics to join those from the internal thoracic L.Ns., anterior mediastinal & posterior mediastinal L.Ns. to form bronchomediastinal lymph trunk.
 - the Rt. broncho-mediastinal lymph trunk ends by joining the Rt. lymphatic duct.
 - the Lt. " " " " " " " " thoracic duct.

The Thoracic Duct

* it is the largest lymphatic vessel in the body (45 cm. long).

* Site: it extends from the upper part of the abdomen to the lower part of the neck.

* shape: it is a thin-walled vessel which has a beaded appearance (due to presence of many valves).

* beginning: it begins in the abdomen as a continuation of the upper end of the cisterna chyli (see page 87) at the lower border of T12.

* Course & relations :

(1) it enters the thorax through the aortic opening of the diaphragm to reach the post. mediastinum.

(2) in the post. mediastinum:

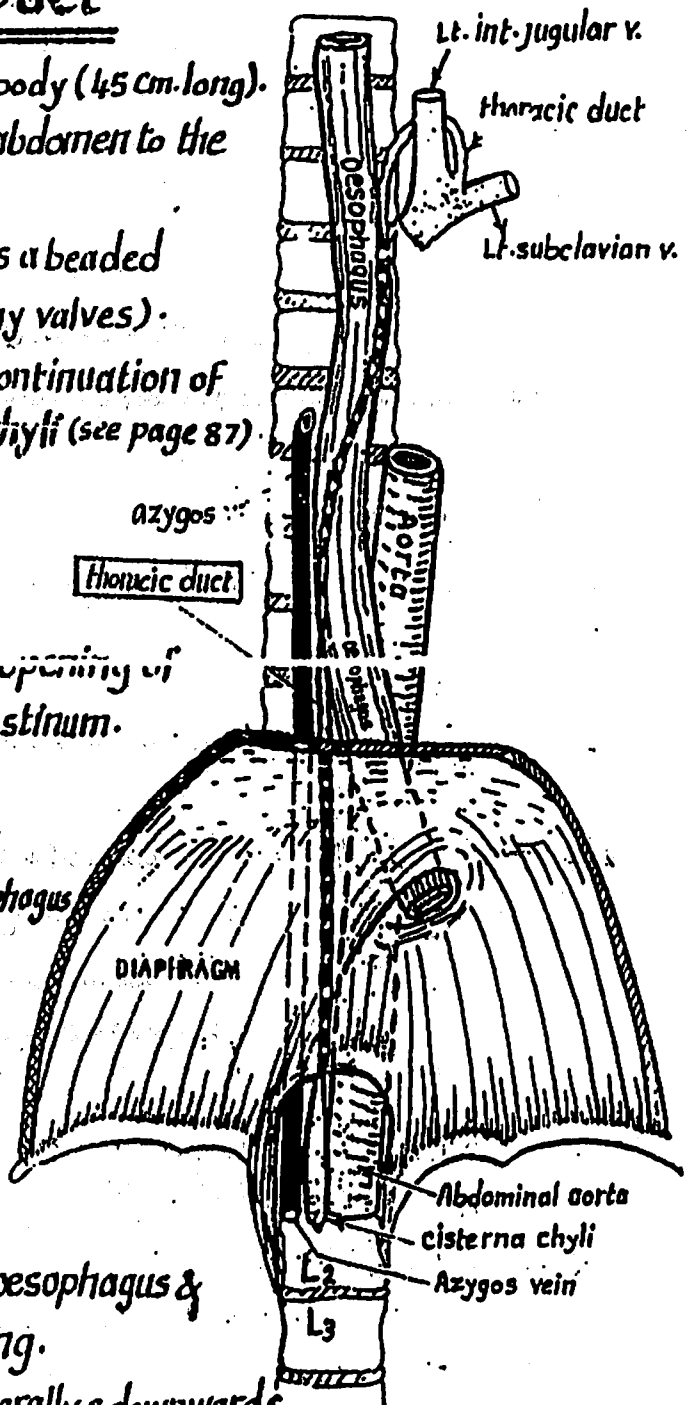
- it ascends in front of the vertebral column behind the diaphragm & Rt. border of the oesophagus
- the aorta lies to its left side while the azygos v. lies to its right side.

(3) At the level of T5: it crosses behind the oesophagus from right to left.

(4) In the sup. mediastinum:

it ascends behind the Lt. border of the oesophagus & is related laterally to the Lt. pleura & lung.

(5) At the root of the neck: it curves laterally & downwards to end by opening in the angle between the Lt. subclavian v. & Lt. internal jugular v.

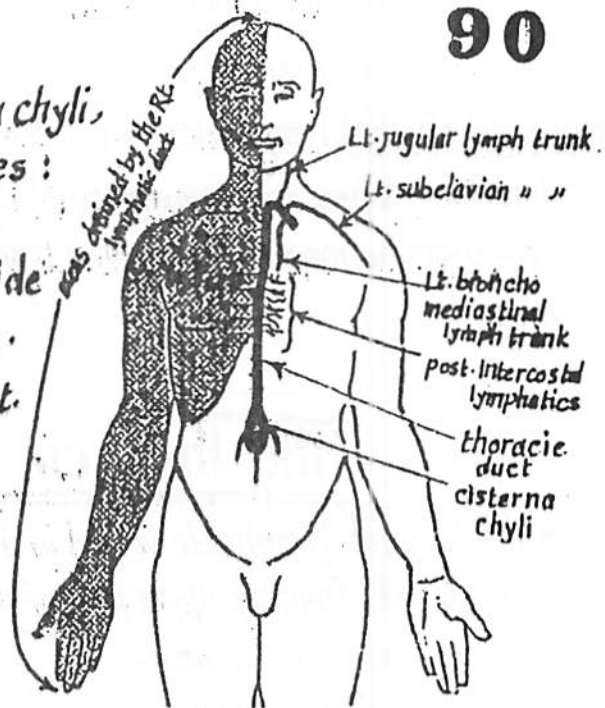


* Tributaries of the thoracic duct:

90

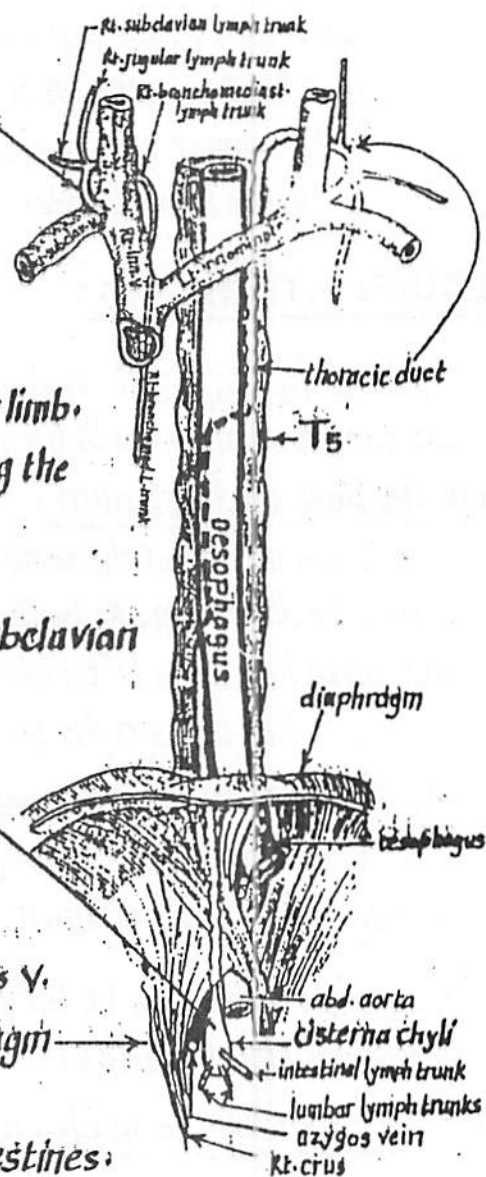
In addition to the tributaries of the cisterna chyli, the thoracic duct has the following tributaries:

- (1) lymphatics from the post-intercostal L.Ns.
- (2) the Lt. jugular lymph trunk: draining the Lt. side of the head & neck.
- (3) the Lt. subclavian lymph trunk: draining the Lt. upper limb.
- (4) the Lt. bronchomediastinal lymph trunk: may join the duct or more commonly it may open separately into the Lt. innominate V.



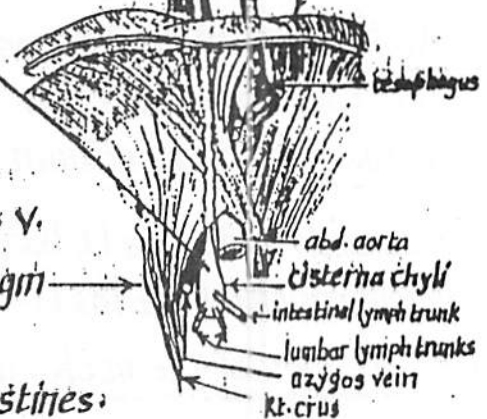
The Rt. lymphatic duct

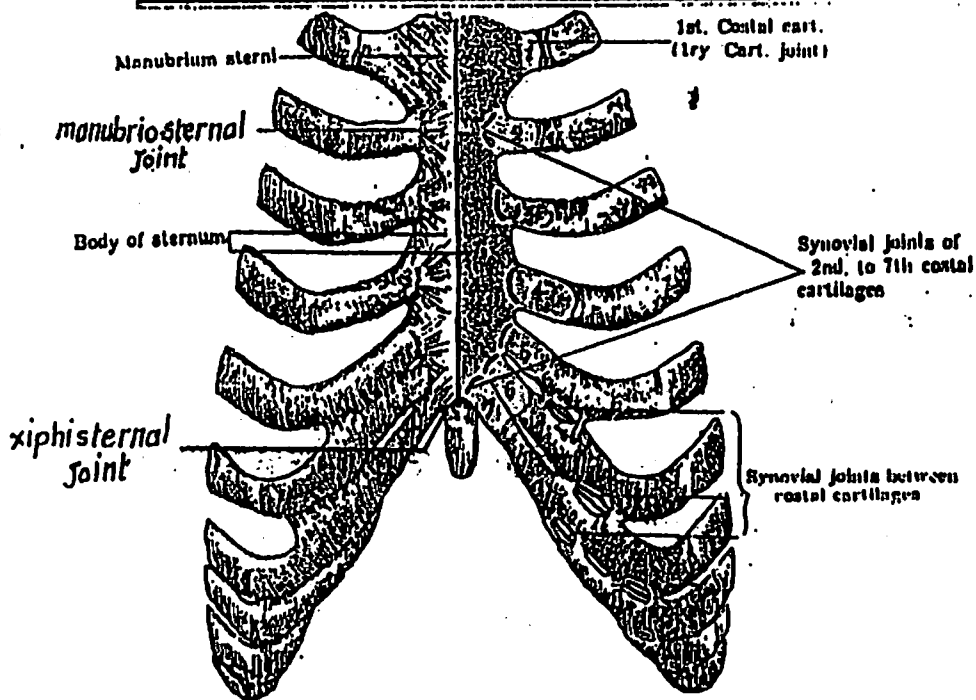
- * it is a short lymph trunk (1 cm. long).
- * it lies in the root of the neck.
- * it is formed by the union of the following:
 - (1) the Rt. jugular lymph trunk: draining the Rt. side of the head & neck
 - (2) the Rt. subclavian lymph trunk: draining the Rt. upper limb.
 - (3) the Rt. broncho-mediastinal lymph trunk: draining the Rt. side of the thorax.
 - (4) Lymphatics from the upper surface of the liver.
- * the duct ends in the junction between the Rt. subclavian V. & Rt. internal jugular V. (I.J.V.).



The Cisterna chyli

- * It is a spindle shaped lymph sac about 2" long.
- * it lies in front of the upper 2 lumbar vertebrae between 2 structures: abd. aorta (to the Lt.) & azygos V. (to the Rt.) & is overlapped by the Rt. crus of diaphragm.
- * It receives the following tributaries:
 - (1) Intestinal lymph trunk: draining the lymph from the intestines.
 - (2) Rt. & Lt. lumbar lymph trunks: draining the lower limbs & all the abdomen except the upper surface of the liver.
- * Its upper end tapers forming the thoracic duct.



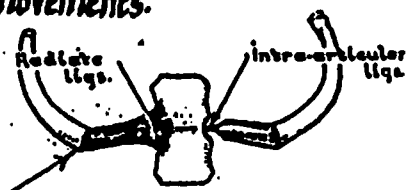


(A) Sternal joints:

- (1) manubriosternal joint (2ry cartilagenous joint) : between manubrium & body :
 - it permits slight movements of the body of the sternum during respiration.
 - in about 10% of subjects it becomes ossified leading to fusion of the 2 bones.
- (2) Xiphisternal joint : 1ry cartilagenous joint between the body & xiphoid process
it ossifies after the age of 40 years.

(B) Chondro-sternal joints:

- (1) the 1st ch-sternal joint is 1ry cartilagenous. It permits no movements.
- (2) the remaining (2nd to 7th) joints are synovial joints having capsules & reinforced by an intra articular ligs & radiate ligs.



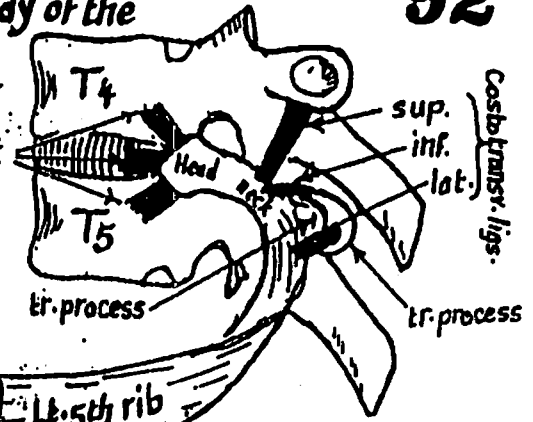
(C) Costo-chondral joints: are 1ry cartilagenous joints

(D) Interchondral joints: lie between the Costal Cartilages 5, 6, 7, 8 & 9. They articulate with one another by synovial joints. The 9th Costal Cartilage

(E) Costo-vertebral joints:

- the joints between the heads of the ribs & the vertebral column are plane synovial joints.
- the head of each non-typical rib (1st, 10th, 11th & 12th) articulate with the body of the corresponding vertebra only.

b- the head of each typical rib articulates with the body of the corresponding vertebra, the vertebra above + the inter-vertebral disc between them. The triradiate ligament & the intra-articular lig. support the fibrous capsule.



(F) Costo-transverse joints:

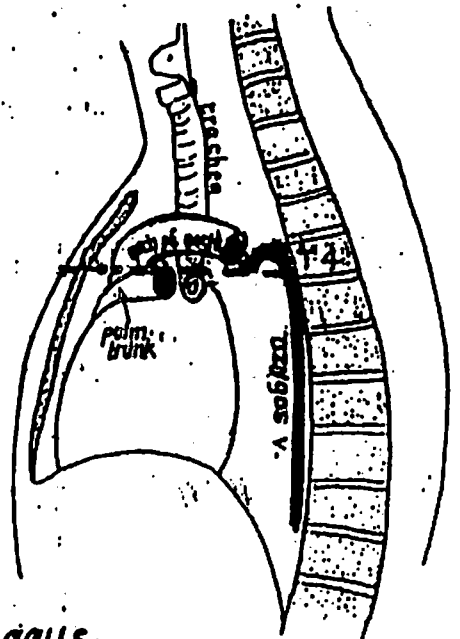
the tubercle of each typical rib articulates with the transverse process of the corresponding vertebra by synovial plane joint. The capsule of the joint is strengthened by 3 ligaments:

- (1) sup. costo transverse lig.: From the upper border of the neck to the lower border of the transverse process of the vertebra above.
- (2) lat. costo transverse lig.: thickened part of the capsule between the rough part of the tubercle & the tip of the tr. process of the corresponding vertebra.
- (3) inf. costo transverse lig.: between the back of the neck of the rib & the front of the tr. process of the corresponding vertebra.

Anatomical events at the level of lower border of T4 Vertebra:

The plane passes through:

- (1) the lower border of the manubrium (the sternal angle).
- (2) the bifurcation of the trachea.
- (3) the concavity of the arch of aorta.
- (4) the bifurcation of the pulmonary trunk (just below the plane).
- (5) the opening of the azygos v. into the S.V.C.
- (6) the ligamentum arteriosum.
- (7) the superficial & deep cardiac plexuses.
- (8) the thoracic duct reaches the left side of the oesophagus.



VERTEBRAL COLUMN

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* Functions:

- (1) provides a central axis to the body.
- (2) supports the weight of the trunk & transmits it to the lower limbs.
- (3) protects the spinal cord which lies inside the vertebral canal.

* Structure:

It consists of vertebrae which, with the exception of sacrum & coccyx, are separate bones bound to each other by intervertebral discs (Fibro-cartilage) & ligaments.

* Regions: the 33 vertebrae of V. column are grouped as follows:

- Cervical : 7 vertebrae ----- in the back of the neck.
- Thoracic : 12 " " " " " " " " thorax.
- Lumbar : 5 " " " " " " " " abdomen.
- Sacral : 5 " " " " " " " " fused together forming the sacrum.
- Coccygeal : 4 " " " " " " " " coccyx.

* Length:

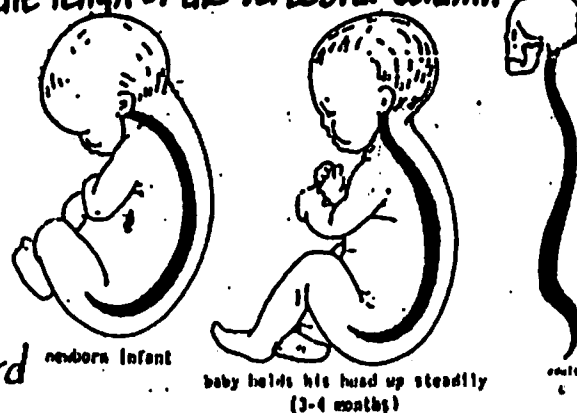
- (A) in the Male: the average length is 70 cm.
 (B) " " Female: " " " " 60 cm.

N.B: the intervertebral discs constitute 1/5 of the length of the vertebral column.

* Curves of the Vertebral column:

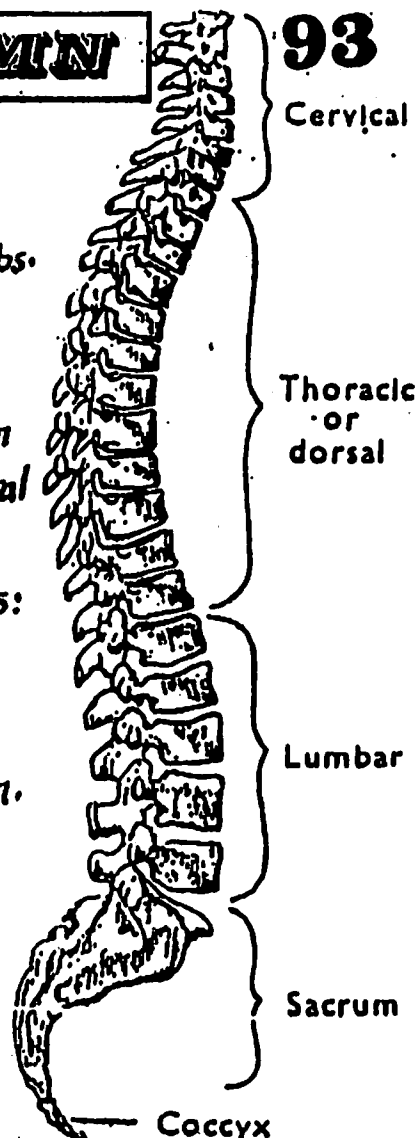
(A) primary curves (thoracic & sacral):

- they are concave forwards & present in the thoracic & sacral regions
- they are present at birth, retaining the forward concavity of the foetal vertebral column.
- they are due to the shape of the vertebral bodies.



(B) Secondary curves (cervical & lumbar):

- they are convex forwards & present in the cervical & lumbar regions.
- they are postural (Compensatory) occurring as follows:
 - (1) the cervical curve appears 3 to 9 months after birth (when the infant holds his head up).
 - (2) " lumbar " " 12 to 18 " " " (when the child assumes the upright posture).
- they are due to the shape of the intervertebral discs.

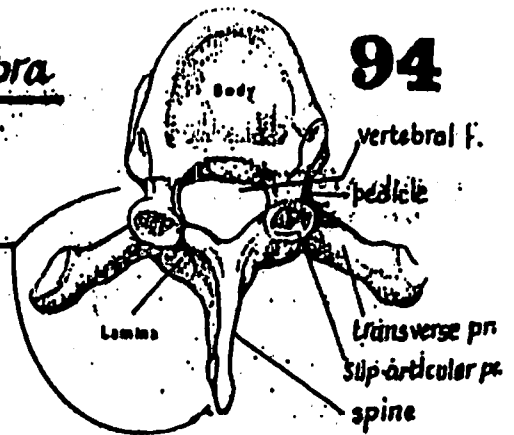


General Features of a typical Vertebra

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a) typical vertebra consists of :

- (1) **Body** : the anterior compact part of the vertebra.
- (2) **Vertebral arch** : the post. part having several processes.
- (3) **Vertebral foramen** : between the body & vertebral arch.



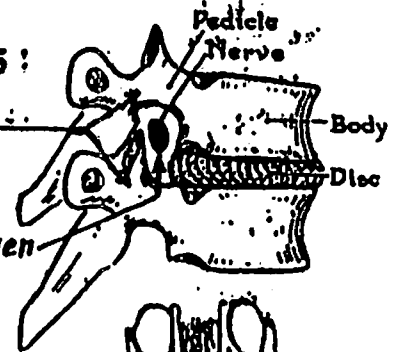
* Body of the Vertebra :

- Its size increases from above downwards as it transmits the body weight.
- It consists of spongy bone covered by a shell of compact bone.
- It has upper & lower flat surfaces for attachment of the intervertebral discs.
- Its ant. surface is convex while its post. surface is flat & both contain vascular foramina.

* Vertebral (neural) arch : consists of the following parts :

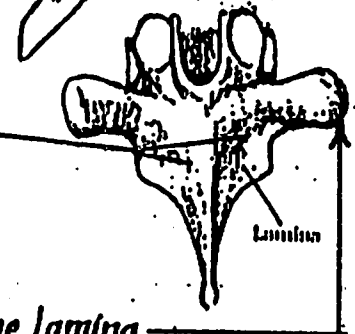
(a) Pedicle (one on each side) :

- It is the part extending from the body to the transverse pr.
- Between 2 successive pedicles there is an intervertebral foramen which gives exit to spinal nerve.



(b) Lamina (one on each side) :

- It is the flat plate between the transverse pr. & the spine.
- The successive laminae are connected by ligamenta flava.



(c) Transverse process : (one on each side) :

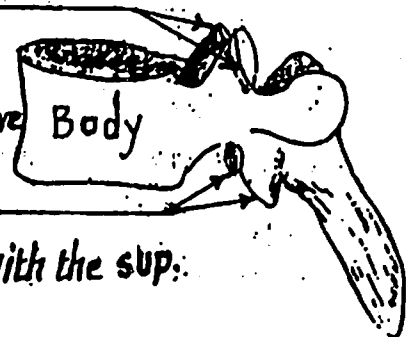
- It projects laterally at the junction of the pedicle with the lamina.
- It serves for attachments of muscles & ligaments and acts as lever for the rotatory & side movements of the V. column. It also acts as fulcrum for the rib.

(d) Spine (Spinous process) :

- It projects backwards at the meeting of the 2 laminae.
- It is the only part of the vertebra which could be felt subcutaneously.
- It serves for the attachment of ligament & muscles (particularly of extension).

(e) 2 Superior articular processes :

- Project upwards & carry 2 articular facets for articulation of the inf. articular processes of the vertebra above.



(f) 2 inferior articular processes :

- Project downwards & carry 2 facets for articulation with the sup. articular processes of the vertebra below.

N.B : the articular processes prevent forward slipping of vertebrae.

* Vertebral Foramen : contains :

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- (a) spinal cord & its covering meninges.
- (b) arteries & veins of the spinal cord & the internal vertebral venous plexus.
- (c) roots & ganglia of the spinal nerves.
- (d) loose fatty tissue.

CERVICAL VERTEBRAE

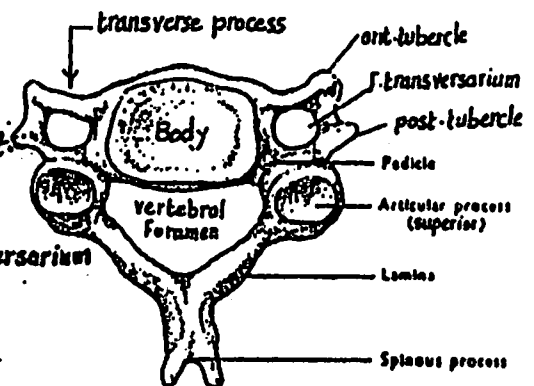
* They are 7 in number. All are characterized by the presence of foramen transversarium in the transverse processes.

* They are classified into : (a) typical vertebrae : these are 3, 4, 5, 6
(b) nontypical " : these are 1, 2, 7.

(A) Typical Cervical Vertebrae (3, 4, 5, 6) :

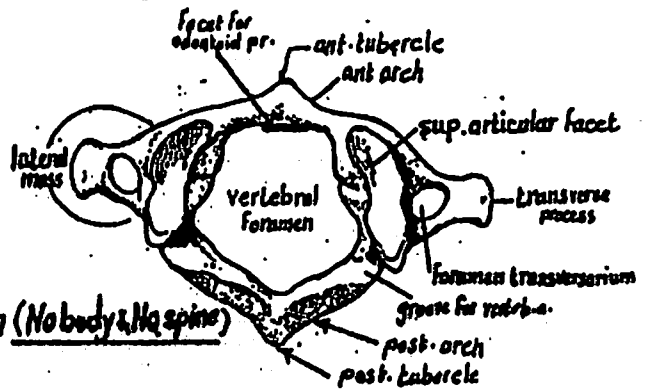
they are characterized by the following features :

- (1) the Body : is small in size & has 2 lat. lips above, ant. post. lip : below.
- (2) the transverse process : is perforated by foramen transversarium & has ant. & post. tubercles.
- (3) the Spine : is short & bifid.
- (4) the sup. articular processes are directed posterosuperiorly while the inf. articular processes are directed anteroinferiorly.
- (5) the vertebral foramen is large & triangular.



(B) The Atlas (1st cervical) vertebra :

- * it is ring-shaped & formed of 2 lat. masses connected by short ant. arch & long post. arch (No body & no spine)
- * the ant. arch has
 - ant. tubercle : anteriorly
 - facet for articulation with odontoid process : posteriorly.
- * the post. arch has
 - post. tubercle : posteriorly.
 - groove for vertebral a. on its upper surface.



* each lat. mass has :

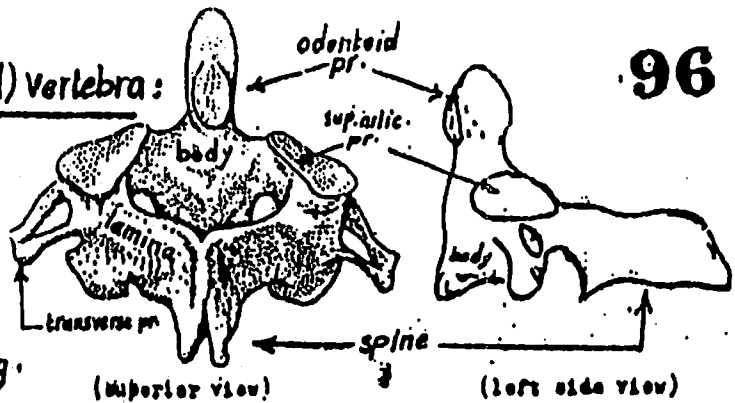
- (1) superior kidney-shaped facet for articulation with occipital condyle of skull.
- (2) inferior circular facet for articulation with the sup. articular facets of axis.
- (3) transverse process containing foramen transversarium.

N.B : the atlas has no body & no spine. Its body is separated from it & fused with the axis vertebra forming the odontoid process.

(C) The Axis (2nd cervical) vertebra:

it has the following features:

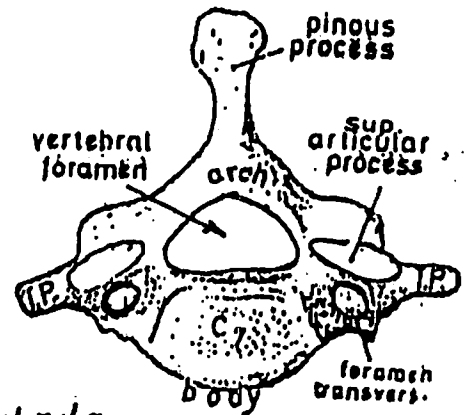
- (1) its body projects upwards forming the odontoid process
- (2) its spine is thick & very strong.



(D) The Vertebra prominens (C7)

it has the following features:

- (1) its spine is long & blunt (not bifid) & it is the 1st spine felt subcutaneously at the back of neck.
- (2) its foramen transversarium is small & may be absent on one side & does not transmit vertebral a. but transmits accessory vertebral vein.



THORACIC VERTEBRAE

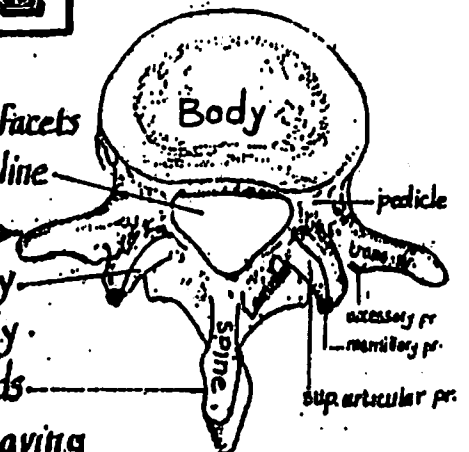
see page 4

LUMBAR VERTEBRAE

* Characteristics:

- (1) the body: large in size, kidney-shaped & has no costal facets
- (2) the vertebral foramen is small in size & triangular in outline
- (3) the transverse process is flat & elongated
- (4) the sup. articular facets are concave & directed medially
- (5) " inf. " " " " Convex & " laterally.
- (6) the spine is quadrilateral & projects directly backwards

N.B: the 5th lumbar vertebra differs from the rest in having a thick strong transverse process which is attached to the pedicle.



How to identify the vertebra (cervical, thoracic or lumbar)?

- (1) a Cervical vertebra has a small body & a Foramen transversarium in the transverse process.
- (2) a thoracic vertebra has a heart-shaped body which bears costal facets on its side.
- (3) a lumbar vertebra has a large kidney shaped body & has neither costal facets nor foramen transversarium.

A-the Sernum

- (1) sternal puncture: the sternum is a common site for bone marrow biopsy because:
 - (a) it contains red hematopoietic marrow throughout life
 - (b) it is subcutaneous & has thin cortical bone thus easily punctured by a wide-bore needle under local anaesthesia.
- (2) Sternal splitting: the sternum may be split longitudinally at thoracic operations to allow the surgeon to gain access to the heart, great vessels & thymus gland.

B-Ribs

- (1) Cervical rib: is an extra rib attached to the 7th cervical vertebra (in 0.5% of persons). Its ant. end may be free or connected to the first rib by a fibrous band.
 - Clinical importance: cervical rib is present in 0.5% of people & may cause:
 - (a) pressure on the lower trunk of the brachial plexus causing pain along the med. side of the forearm & wasting of the muscles of the hand.
 - (b) pressure on the overlying subclavian a. causing ischaemia of the upper limb.
 - (2) Fracture of ribs:
 - Causes: car accidents & crush trauma to the chest.
 - age incidence: it is rare in children because ribs are highly elastic. It is common in adults affecting one or more ribs.
 - Site of fracture: commonly in the region of the angle (weakest point).
- N.B (a) in severe crush injuries a number of ribs may break at 2 sites (near the angle & anteriorly) this causes flail chest. The flail segment shows paradoxical respiratory movement i.e. sucked during inspiration & driven out during expiration.
- (b) a broken rib may pierce $\left\{ \begin{array}{l} \text{the lung causing pneumothorax} \\ \text{the liver} \\ \text{, spleen} \end{array} \right\}$ causing internal haemorrhage

C- intercostal nerves

- (1) irritation of the intercostal nerve e.g. by pressure or disease in the vertebral column causes severe pain which is referred to the peripheral termination of the nerve in the chest or abdomen.
- (2) intercostal n. block: is injection of local anaesthesia around the intercostal n. to relieve root pain or girdle pain.
- (3) pus from the vertebral column tends to track around thorax following the course

of the neurovascular bundle, and may point at any of the 3 sites of exit of the cutaneous branches of the thoracic nerve. **98**

D- Pleura

- (1) Pneumothorax : air may enter the pleural cavity from perforation in the lung or through a wound in the chest wall. This will lead to lung collapse.
 - (2) pleural effusion : presence of serous fluid in the pleural cavity.
 - (3) hemothorax : " " blood " " " "
 - (4) Empyema : " " pus " " " "
 - (5) Aspiration of any collected fluid in the pleural cavity is called paracentesis. It is usually done by introducing a wide-bore needle in the 7th intercostal space in the midaxillary line (not below this level to avoid injury of the diaphragm).
-

E- The Lung

- (1) Knowledge of the detailed anatomy of the broncho pulmonary segments (page 30) explains the following facts :
 - (a) infection of a segment remains restricted to it. (Cancer, however, can spread from one segment to another).
 - (b) draining lung abscess requires adopting particular position.
 - (c) a diseased lung segment can be surgically removed instead of entire lobe.
-

F- Pericardium

pericardial effusion : collection of fluid in the pericardial cavity. It can be drained by puncturing the 5th or 6th intercostal space just lat. to the heart apex.

G- Heart

- (1) Due to the poor anastomosis between the branches of the Rt. & Lt. coronary aa. blockage of a branch of coronary artery (coronary thrombosis) usually leads to death of part of the myocardium (myocardial infarction).
- (2) spasm of a coronary a. (incomplete obstruction) causes angina pectoris which is associated with agonising pain in the front of the chest & referred to the Lt. shoulder & med. side of the left upper limb.
- (3) most of the conducting system of the heart is supplied by the Rt. coronary a. so, vascular lesions of this artery can cause a variety of arrhythmias.

Arch of Aorta

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- (1) Aortic knuckle: in p.A view of x-ray photographs of the chest, the arch of aorta appears as a projection beyond the left margin of the mediastinal shadow & is called the aortic knuckle.
- (2) Coarctation of aorta: a localized narrowing of aorta opposite to, or just distal to the attachment of the ductus arteriosus. This leads to the development of extensive collateral circulation between brs. of subclavian aa. & those of desc. aorta.
- (3) Aortic aneurysm: is a localized dilatation of the aorta which may press upon the surrounding structures causing the mediastinal syndrome (see page 36).



The superior vena cava (S.V.C)

- (1) if the S.V.C is obstructed above the opening of the azygos V., the venous blood of the upper $\frac{1}{2}$ of the body is returned to the heart via the azygos V.
- (2) if the S.V.C is obstructed below the opening of azygos V., the blood is returned through the I.V.C via anastomotic channels (see page 75).

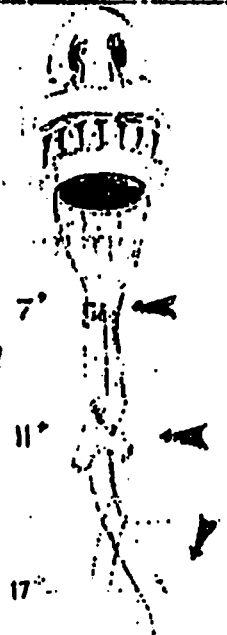
The Trachea & The Bronchi

- (1) Tracheostomy: surgical opening of the trachea in case of laryngeal obstruction. it should be done exactly in the middle line above the suprasternal notch to avoid injury of the large blood vessels.
- (2) the trachea may get compressed by pathological enlargement of the thyroid gland, the arch of aorta or by lymph nodes.
- (3) Carina is the angle between the 2 bronchi as seen internally by the bronchoscope. This angle becomes wide & distorted in case of malignant enlargement of the tracheobronchial lymph nodes.
- (4) A Foreign body which may enter the trachea usually passes to the Rt. bronchus because (a) it is wider in diameter (b) it is more in line with the trachea.



The Oesophagus

- (1) the normal constrictions should be kept in mind (7, 11, 17 inches from the lower incisor teeth) as seen during oesophagoscopy. These 3 normal constrictions may be sites of foreign body impaction.
- (2) Left atrial enlargement (as in mitral stenosis) can be detected by barium swallow where the enlarged atrium causes shallow depression on the front of the oesophagus.
- (4) In oesophageal varices caused by portal hypertension, there is opening of the communications between the portal & systemic veins supplying the lower end of the oesophagus. Rupture of these varices can cause serious haematemesis.



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